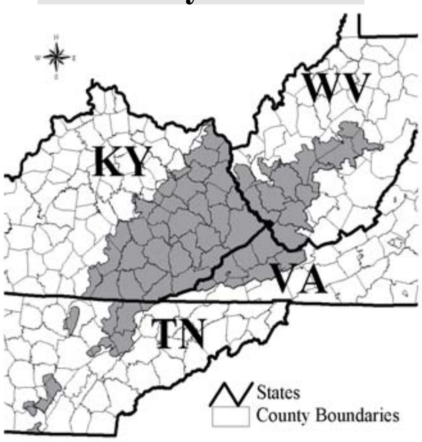
III. AFFECTED ENVIRONMENT AND CONSEQUENCES OF MTM/VF

THESE ECOREGIONS ARE UNIQUE IN THE WORLD BECAUSE THEY COMBINE CHARACTERISTICALLY NORTHERN SPECIES WITH THEIR SOUTHERN COUNTERPARTS, AND THUS BOAST ENORMOUS RICHNESS AND DIVERSITY

This chapter includes a description of the physical setting, Appalachian lotic and lentic aquatic systems, relationship of surface mining and water quality, Appalachian forest communities, Appalachian microhabitats, threatened and endangered species, coal mining methods, mountaintop mine characteristics, excess spoil disposal, and economic information. Supporting information is provided in the appendices.

A. DESCRIPTION OF THE STUDY AREA

Figure III.A-1
Study Area



The Appalachian Coalfield Region encompasses the coal-bearing areas of Pennsylvania, Ohio, Maryland, North Carolina, Georgia, West Virginia, Virginia, eastern Kentucky, Tennessee, and Alabama. The Bituminous Coal Basin lies within the Appalachian Plateau physiographic province, extends in a northeast to southwest direction along the Appalachian Mountains, and encompasses the most historically important coal mining areas of the Appalachian Coalfield Region (USDOI OSM, 1983). The study area is located within the Appalachian Coalfield Region of the Appalachian Plateau physiographic province and Bituminous Coal Basin. As the name implies, this region is known for the substantial deposits of coal that lie beneath the surface. Consistent with the EIS purpose, the study area includes watersheds where excess spoil fills, otherwise known as valley fills, have been constructed or are likely to be constructed in the future.

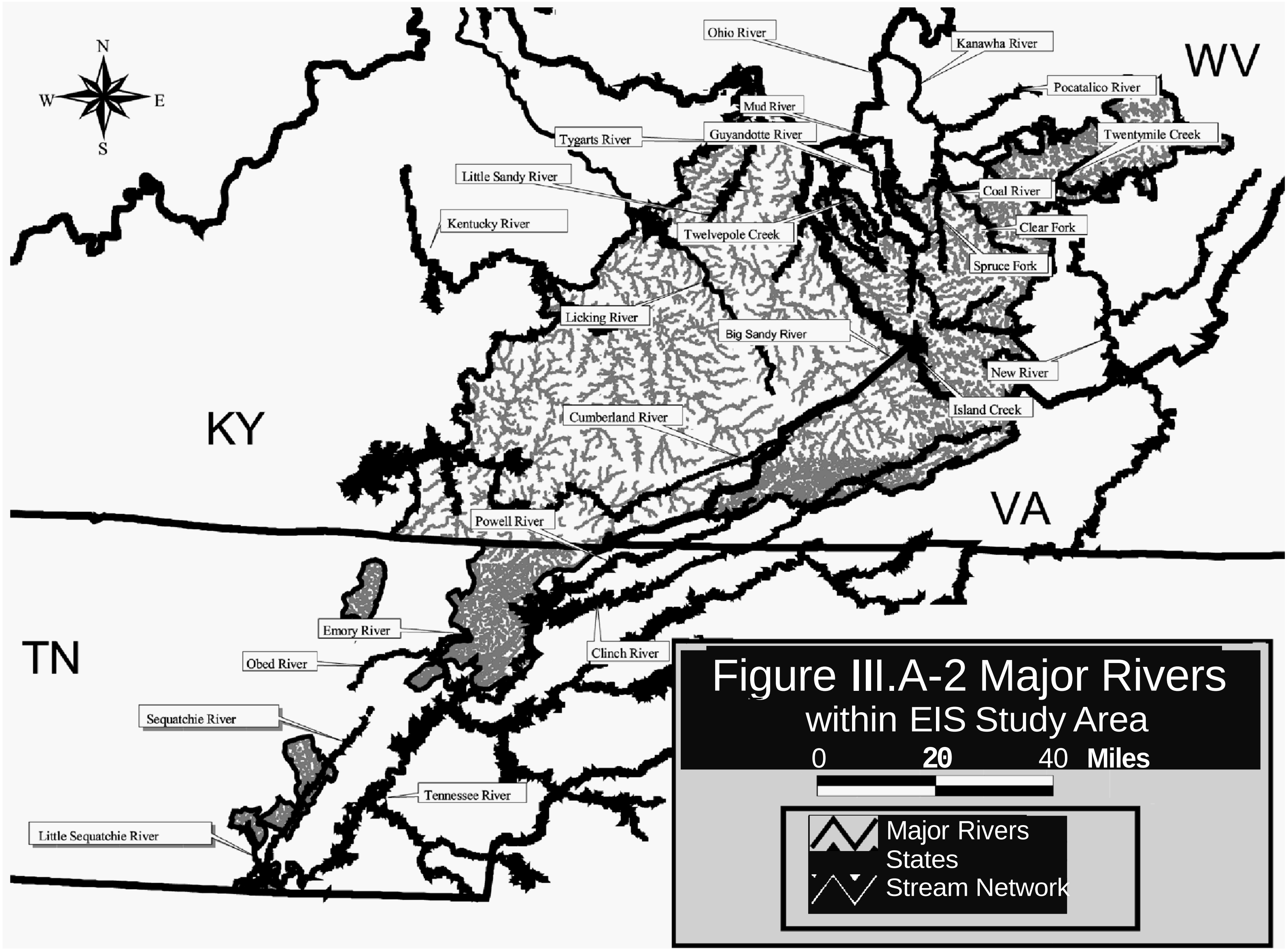
Physically, two factors must be coincident in order for mountaintop mining to occur and for excess spoil to be generated: steep terrain and sufficient contiguous coal reserves located close enough to the tops of mountains and ridges to justify large scale mining. In West Virginia, this close combination exists in the southern half of the state and is most frequently aligned with the existence of the Coalburg coal seam. In Kentucky, Virginia and Tennessee, this combination of factors also exists but delineation is not quite as simple because of more complex geology. The study area is approximately 12 million acres and extends over portions of West Virginia, Kentucky, Virginia, and Tennessee [Figure III.A-1 - Study Area].

The rugged terrain of this region is generally characterized by steep mountain slopes, confined river valleys, and narrow ridge tops. The geologic processes and climatic conditions responsible for the formation of these land forms, have as a result, helped to determine the past and present land use and land cover of the region. The regional topography, and the coal it contains, have been significant driving forces behind human settlement and development patterns throughout the region. The very history of the region has been shaped by coal, and the region itself marked by the continuous attempts to extract it. Federal law also requires the maximum utilization of the natural resource so that disturbing the land in the future will not be necessary.

THE RUGGED TERRAIN OF THIS REGION IS GENERALLY CHARACTERIZED BY STEEP MOUNTAIN SLOPES, CONFINED RIVER VALLEYS, AND NARROW RIDGE TOPS

Settlement patterns in the Appalachian Coalfield Region were constrained by the dominant topographic features of the area, such as rivers, streams, mountains, and valleys. Communities settled along rivers and within valleys primarily for transportation and agricultural purposes. The coal deposits, as well as the physical limits to other types or forms of development, have defined the locations and extent of settlement and distribution. Within the study area, there is a relative scarcity of land suitable for agriculture and conventional residential, commercial, and industrial development. As a result, the limited settlement and development of the region has occurred almost exclusively on valley floors along stream and river courses. The current road and rail transportation networks generally follow the network of streams. Although the land was largely unsettled, there was significant timber cutting, and today's forests are largely second and third growth. Private and public forests provide lumber and pulpwood, recreational opportunities, wildlife habitat, and the opportunity for harvesting non-traditional forest products.

Water is relatively abundant throughout the study area. Figure III.A-2 depicts major rivers within the study area. Most of the major rivers and tributaries in the United States east of the Mississippi originate in the mountains of the Appalachian regions (USDOI OSM, 1999a). Outside of urban areas, shallow groundwater wells provide most of the water for domestic use (Heath, 1984). Vital to the health of an aquatic ecosystem is the quality of its water.


N
S
E
W
WV
KY
VA
TN
Ohio River
Kanawha River
Pocatalico River
Mud River
Guyandotte River
Tygarts River
Twentymile Creek
Little Sandy River
Coal River
Kentucky River
Clear Fork
Twelvepole Creek
Spruce Fork
Licking River
Big Sandy River
New River
Island Creek
Cumberland River
Powell River
Emory River
Obed River
Clinch River
Sequatchie River
Tennessee River
Little Sequatchie River
Figure III.A-2 Major Rivers
within EIS Study Area
0
20
40
Miles
Major Rivers
States
Stream Network

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The regional history of coal mining extends back well over a century. Remnants of earlier mining operations, as well as mines which are in operation today, have influenced the natural environment of the region. Of particular environmental concern are those resources which have the most potential for being significantly affected by the adverse impacts of coal mining. For example, the rivers and streams, and the aquatic ecosystems they maintain. An aquatic ecosystem is composed of three components: the biological, the chemical, and the physical, and any or all of them may be impacted by mining activities.

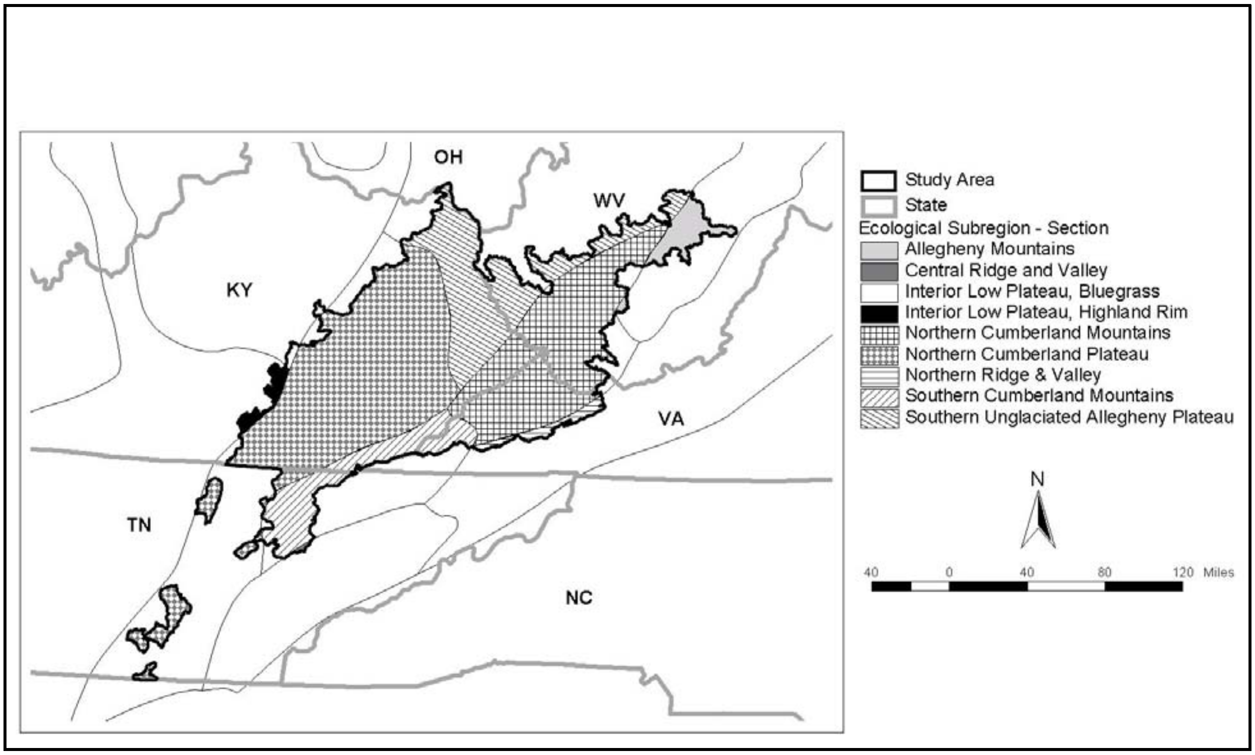
To assess the programs that monitor and govern the impacts that mining may have on aquatic and terrestrial ecosystems, it becomes necessary to consider and discuss issues in "natural" terms. By identifying and organizing environmental issues within natural boundaries, instead of partitioning areas based on arbitrary political boundaries such as state or county lines, natural resources may be considered within their own context. Two such "natural" categories of division are watersheds and ecoregions.

Watersheds are a clearly-defined unit of land that represents the area drained by a stream and all its tributaries. A watershed can include lakes, rivers, wetlands, streams, the surrounding landscape, and may also include ground water recharge areas. The watershed approach is useful because it focuses more specifically on drainage patterns, water quality, and aquatic ecosystems. The use of ecoregions and watersheds as "natural" units of area can depend highly on the scale of observation. For example, an ecoregion may contain countless small watersheds, while conversely, a large watershed (such as the Ohio River) may contain many ecoregions. For the purposes of classification, the study area watersheds are referred to individually by their 11 digit Hydrological Unit Code (HUC) assigned by the United States Geological Survey (USGS). For example, the Clear Fork watershed is located entirely within Raleigh County, West Virginia. The watershed consists of the Clear Fork itself, all the tributaries that flow into and contribute to the Clear Fork, and all the surrounding land from which the runoff and groundwater flow into the Clear Fork and its tributaries. Beginning at the highest points which surround the Clear Fork, headwater streams form which serve as the surface collection points for all surface and ground water within the watershed. As these headwater streams flow downhill, they join other headwater streams to form larger tributaries. Depending on their relative size and prominence, tributary streams may or may not be named. Further information on representative streams is provided in section III.C. of this EIS.

Ecoregions are areas of relatively similar landscapes. Across an ecoregion, one will find that climate patterns, physiography, geology, soils, and vegetation vary little. Ecoregions can be further subdivided into subregions, landscapes, and land units, each at a different planning and analysis level scale. Analysis at the ecological subregion level is of considerable value when the purpose is for strategic, multi-forest, statewide, and multi-agency assessment because several variables are considered when defining the boundaries of each ecological subregion (USDA, U.S. Forest Service 2002). The ecological units of an ecological subregion analysis are termed *sections*. Within an ecological subregion section geomorphology, lithology, soils, vegetation, fauna, climate, surface water characteristics, disturbance regimes, land use, and cultural ecology are generally similar.

The study area is located within portions of nine ecological subregion sections [See Figure III.A-3 - Ecological Subregion Sections]. Characteristics of each ecological subregion section of the study area are summarized in Table III.A-1 - Ecological Subregion Section Characteristics.

Figure III.A-3
Ecological Subregion Sections



Ecoregional analysis at a national level has highlighted the biological significance of the Appalachian ecoregions. These ecoregions are unique in the world because they combine characteristically northern species with their southern counterparts, and thus boast enormous richness and diversity. That, in combination with relatively mild environmental conditions, have provided a perfect setting for the evolution of unique species of plants, invertebrates, salamanders, crayfishes, freshwater mussels, and fishes. These species include great numbers of organisms, including terrestrial, aquatic, and plant species, which are supported by the Appalachian ecoregions (Stein et.al., 2000). The southern Appalachians have one of the richest salamander faunas in the world (Petranka 1998, Stein et.al., 2000). The Appalachian ecoregion forests represent some of the last remaining stands of a forest type that was once widespread in the northern hemisphere. These rich deciduous forests have been profoundly altered over the past few centuries and are becoming increasingly threatened.

Table III.A-1
Ecological Subregion Section Characteristics

Ecological Subregion	**Geomorphology (Province)**	**Natural Vegetation (Forest Type)**	**Climate (Mean Annual)**
Allegheny Mountains	Appalachian Plateaus	Northeastern Spruce-Fir Northern Hardwoods Mixed Mesophytic Oak-Hickory-Pine	Prec: 46-60" Temp: 39-54˚F
Central Ridge and Valley	Ridge and Valley	Appalachian Oak	Prec: 36-55" Temp: 55-61 ˚F
Interior Low Plateau, Bluegrass	Interior Low Plateaus	Oak-Hickory	Prec: 44" Temp: 55 ˚F
Interior Low Plateau, Highland Rim	Interior Low Plateaus	Oak-Hickory	Prec: 44-54" Temp: 55-61 ˚F
Northern Cumberland Mountains	Appalachian Plateaus	Mixed Mesophytic Appalachian Oak Northern Hardwoods	Prec: 40-47" Temp: 45-50 ˚F
Northern Cumberland Plateau	Appalachian Plateaus	Mixed Mesophytic Appalachian Oak	Prec: 46" Temp: 55 ˚F
Northern Ridge and Valley	Ridge and Valley	Appalachian Oak Oak-Hickory-Pine Northern Hardwoods	Prec: 30-45" Temp: 39-57 ˚F
Southern Cumberland Mountains	Appalachian Plateaus	Appalachian Oak Mixed Mesophytic	Prec: 46" Temp: 55 ˚F
Southern Unglaciated Allegheny Plateau	Appalachian Plateaus	Mixed Mesophytic Appalachian Oak	Prec: 35-45" Temp: 52 ˚F

Source: U.S. Forest Service, USDA, 2002

B. PHYSICAL SETTING

1. Physiographic Province

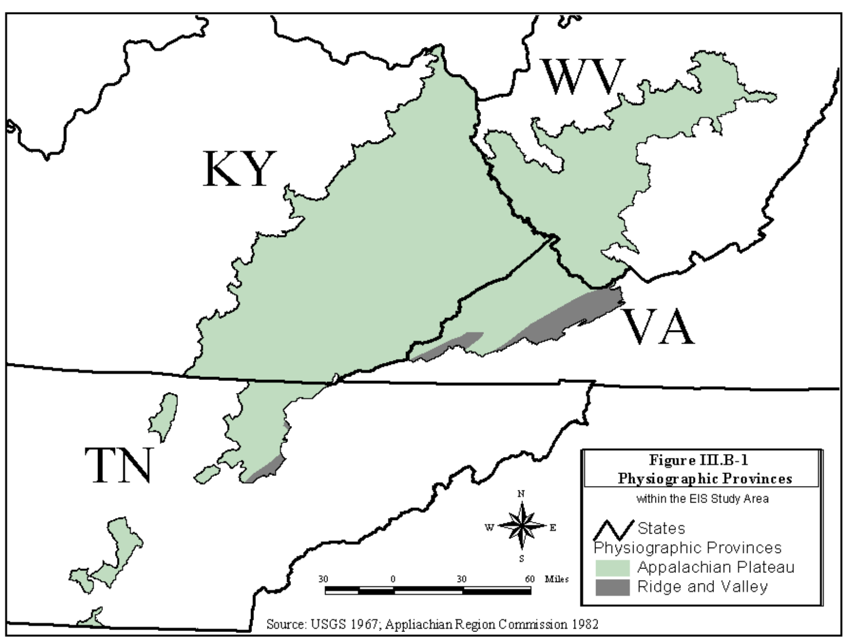
Physiographic provinces are a useful means of grouping land forms. The definition of a physiographic province is a geographic region in which climate and geology have given rise to an array of land forms that are notably different from those of surrounding regions. The feasibility and methods of coal mining in a given region are highly dependent on geologic conditions and land forms, so physiographic provinces are also useful in grouping the extent and various styles of mining within the Appalachian coalfields.

The Appalachian mountains form a wide belt (exposed width between 93 and 373 miles) that trends from Newfoundland to Alabama. The Appalachian mountains can be divided into three sections: (1) a northeastern section covering northern Maine and the maritime provinces of Canada; (2) a New England section covering portions of Vermont, New Hampshire, and New York; and (3) the Appalachian Highlands. The Appalachian Highlands section is comprised of the Ridge and Valley Physiographic Province and the Appalachian Plateau Physiographic Province. As shown on Figure III.B-1, the majority of the study area for this EIS is within the Appalachian Plateau Province.

The Allegheny Front separates the Appalachian Plateau Province from the Ridge and Valley Province. The Allegheny Front is a zone of transition between the tightly folded strata of the Ridge and Valley Province and the nearly horizontal sedimentary rocks of the Appalachian Plateau Province.

The Ridge and Valley Province is characterized by northeast-southwest trending mountains and valleys. In general, the valleys and lowlands are underlain by shales and limestones, and the ridges are composed of more resistant sandstones and conglomerates.

The Appalachian Plateau Province of the Appalachian Highlands includes the Pocatalico River, Coal River, New River, and the main stem of the Kanawha River drainage basins. It also includes small parts of the Ohio River and Bluestone River drainage basins. Differential stream erosion and repeated regional uplifts have given the plateau a rugged topography characterized by high, rounded or flat-topped ridges, rolling hills, steep valley slopes, and narrow valley floors.



2. Geology

Since coal mining involves the extraction of a geologic deposit, geologic conditions are an important factor in determining the extent and practicality of coal mining on a given site. Geologic considerations for coal mining include the depth, sequence, and thickness of coal seams, coal quality, and physical nature of the overburden (soil and rock that overlies coal) above and interburden (rock in between coal seams). The volume of excess material generated corresponds directly to the swell factors of the rock, which make up the overburden. Therefore, the potential for generating larger volumes of earth is greater with coarser-grained rocks, such as sandstone which has a higher swell factor than with finer-grained rocks, such as shale which has a lower swell factor. The chemical nature of coal and overburden, particularly with regard to pyrite content and the potential for acid mine drainage formation, is also a geologic consideration. These factors are influenced by the original conditions under which the coal deposits were formed, referred to as their environment of deposition, and subsequent deformation by tectonic processes. This section provides a brief overview of the history of formation of the Appalachian coalfields, and a summary of the general geologic conditions found in the four states of the study area. Detailed descriptions of the coalfield environment of deposition, tectonic history, chemical factors controlling acid mine drainage formation, and coal-bearing rock units are contained in Appendix C of this EIS.

a. Regional Geologic History

The Appalachian coalfields were formed during a long period of mountain building along the area of the modern east coast, with the coal beds deposited primarily from 300 to 250 million years ago. Sediments shed from these ancestral Appalachian mountains as they eroded were carried to a large inland sea occupying much of the area of the Appalachian mountain states and known as the Appalachian Basin. Large swamps formed along the margins of this sea and decayed plant matter, or peat, built up within them over time. As sea levels fluctuated, these coal swamps migrated with the shoreline and were buried by additional sediments carried from the mountains. Long-term burial pressures then converted the peat deposits into coal. This coal swamp migration and burial formed multiple layered coal seams typifying the Appalachian coalfields today.

Toward the end of the mountain building period, the collision of the North American and African continents deformed the eastern portion of the Appalachian Basin and produced the steeply folded bedrock characteristic of the Valley and Ridge Province. Further west, the Basin was only slightly deformed, producing gentle anticlines and synclines in the Appalachian Plateau Province. Over time, both the eastern mountains and the basin area were worn flat by erosion and buried by additional sediments. Regional uplift of the eastern states then re-exposed the coal-bearing bedrock to erosion, producing long valleys and ridges in the tightly folded bedrock of the Valley and Ridge Province. The erosion created deeply incised dendritic stream valleys in the relatively flat-lying bedrock of the Appalachian Plateau Province. In the Valley and Ridge Province, uplift and weathering eroded away the coal deposits from much of the area, with the remaining steeply-dipping coal seams more suited to underground mining methods. The same uplift and erosion in the Appalachian Plateau Province resulted in shallow, flat-lying exposures of coal-bearing bedrock that are amenable to surface mining within the study area.

b. State Geology Summaries

The following provides a basic description of the location, form, and structural features of the coal-bearing rocks within the study area.

b.1. Kentucky

Kentucky possesses two major coalfields at the eastern and western ends of the state, separated by a large area of older rocks exposed in a structure known as the Cincinnati Arch (USDOI OSM, 1998a). MTM/VF mining occurs in the eastern coalfield, where coal-bearing rocks underlay approximately the eastern quarter of the state and form a broad, shallow trough or synclinal basin (Kiesler, USGS 1983). Bedrock dips at 5° or less along the margins of the trough and is essentially flat-lying in the central portion of the trough (Kiesler, 1983). Upper Mississippian and Pennsylvanian coal-bearing rocks thicken towards the southeast, reaching their maximum thickness at the southeastern margins of the basin along a structure known as the Pine Mountain Thrust Fault zone. Coal units are disrupted and offset along this fault zone.

b.2. Tennessee

The Tennessee coalfields are in the east central portion of the state and trend northeast to southwest from Kentucky to the Alabama border. As with Kentucky, these coalfields form a broad, shallow trough or synclinal basin that is bounded to the west by a structure known as the Highland Rim escarpment and to the east by the Ridge and Valley Province. These coalfields are generally divided between the northern steep-slope areas of the Cumberland Mountains and the southern, flatter Cumberland Plateau, where area mining dominates (USDOI OSM, 1998b). Bedrock units primarily have a shallow southeasterly dip and thicken to the southeast near the basin's trough adjacent to the Valley and Ridge Province (Gaydos, 1982).

b.3. Virginia

With the exception of a small region in south-central Virginia which is not mined, coal-bearing rocks are present only at the westernmost end of Virginia and are contiguous with the Kentucky and West Virginia coalfields. These are relatively flat-lying rocks bounded on the northwestern and southeastern basin margins by the thrust-faulted and uplifted rock units (Rader, 1993 and Harlow, 1993). Along the northwestern coalfield margin is the Pine Mountain Thrust fault. The southeastern margin is bounded by a series of thrust faults. The Russel Fork fault divides the basin into two regions: (1) the relatively flat-lying rocks northeast of the fault and (2) the gently folded and faulted rocks located southwest of the fault that were moved as part of the Pine Mountain thrust sheet (Harlow, 1993). The rocks of both regions are nearly flat-lying and have an average northwesterly regional dip of 1.4 percent. Due to steep topography, Virginia mines are predominantly underground or contour surface operations, with a limited number of mountaintop removal and area-type operations (USDOI OSM, 1997).

b.4. West Virginia

Coal-bearing rocks underlay much of central West Virginia, extending into Ohio, Pennsylvania, and Maryland. One structural fold known as the Hinge Line separates the Dunkard and Pocahontas Geologic Basins of West Virginia. These basins are characterized by differences in the total thickness of their rocks, as well as by the orientation and distribution of their ancient swamps, lacustrine marine environments, and alluvial deposits (Arkle, 1974). The Dunkard and Pocahontas Basins approximately coincide with the northern and southern coalfields (younger and older mining districts, respectively) of West Virginia. The various formations of sedimentary rocks exhibit local differences in strata north or south of the Hinge Line in response to different depositional environments. For example, the Allegheny and Conemaugh formations in the Dunkard Basin represent a sequence of marine and coastal environments, including deltaic, offshore, and alluvial depositional conditions. In the Pocahontas Basin, these formations predominantly include the alluvial facies of non-marine sandstone, shales, and channel deposits that generally include only limited coal seams. Due to steep topographic conditions, contour, area, mountaintop-removal, and multiple-seam mining operations are the most common methods of surface mining in the state (USDOI OSM, 1998c).

3. Soils

Soils are a critical natural resource and essential for plant life in the natural environment. This resource is a particular concern for surface mining because, by definition, the practice will remove surface materials overlying the coal, including any soil present on the existing land. SMCRA requires that mine operations either preserve and replace soils on the reclaimed land surface to restore their vegetative cover or use an acceptable soil substitute. As discussed in Section III.J, surface mining operations use two methods to restore a vegetative growth substrate to reclaimed mine lands: topsoil removal and redistribution, and topsoil substitution. Both methods result in surface conditions markedly different from those present prior to mining. This section provides background on soils in general and the specific types of soils found within the study area.

a. Soil Characteristics

Because of their importance to agriculture, soils have long been studied to determine their characteristics and the factors that govern their formation and productivity. The following provides a brief overview of the soil formation process, soil profile, and the soil classification system.

a.1. Soil Formation

Soils are a fragile natural resource that require very long periods of time to form, most on the order of thousands to tens of thousands of years or longer. All soils are developed as a result of the interactions between five formation factors: (1) parent material, (2) climate, (3) living organisms, (4) time, and (5) topography. In the study area, the dominant formation factors have been topography, parent material, and time. Parent material is the bedrock, collovium (material moving down hillsides in response to gravity), or alluvium (material deposited by rivers and streams) on which a soil forms. Physical and chemical weathering and biological activity are the processes that form soils on the parent material, the rate of both being related to climate. Weathering is faster in warm, wet climates than in cold, dry climates. Soil formation is an ongoing process, with weathering continuing to attack underlying parent material to form more soil, therefore, the longer that a parent material is exposed to the elements, the greater the weathering and the thicker the soil.

a.2. Soil Profile

Most soils show a distinct layering with individual layers referred to as horizons. There are many internal subdivisions that soil scientists use to characterize soil horizons, but the three basic groupings are called the A, B, and C Horizons. The A Horizon is the surface soil layer usually referred to as topsoil. It is the most weathered portion of the soil column and in vegetated areas will typically have a cover of decayed plant matter and high organic content known as the O Horizon. The B Horizon often referred to as the subsoil, typically contains less organic matter than the A Horizon and more clay. The C Horizon is the slightly weathered or unweathered parent material underlying the B Horizon. The individual horizons represent the downward progression of weathering in the soil formation process, and boundaries between them may be very distinct to very subtle depending on the nature of the soil. In general, older soils will have better developed horizons than younger soils.

a.3. Soil Classification

Soils are classified in the United States by a well-defined taxonomy, with a distinct hierarchy that follows from order, sub-order, great group, subgroup, family, and finally to series. There are twelve soil orders in the US, and in the study area the Inceptisol and Ultisol orders dominate. Inceptisols are immature soils that have weakly expressed horizons and retain a close resemblance to their parent material. They may form from highly resistant parent material or in alluvial floodplains, occur on extreme landscape positions, such as steep slopes and depressions, and have geomorphic surfaces so young as to limit soil development. Ultisols form in humid regions from parent material that has not been affected by glaciation, and thus develop on landscapes that are geologically old compared to glaciated areas. They are highly weathered soils that have a low nutrient content and base status.

b. Study Area Soils

To characterize the soils across a wide region such as the Appalachian coalfields, it is necessary to use soil series associations, rather than list specific soil series. For this study, two primary sources of information were used to collect pertinent data: the USDA, Geological Survey Series on the Hydrology of the Eastern Coal Province (Areas 1 to 23), and the USDA, Natural Resource Conservation Service (formerly Soil Conservation Service) County Soil Surveys.

Important points necessary to note when discussing MTM/VF region soil resources include:

- Historically, soil data have been collected and analyzed primarily for agricultural purposes, with less attention given to soils with lower attached economic value.

- Soil is an extremely heterogeneous material with high degrees of variability possible in its physical properties over a short distance. This is especially true with the non-agricultural soil associations where many different soils with different properties are lumped together.

- The rugged topography of the MTM/VF region has made data collection difficult, and its low agricultural use has made it an area less studied than more intensively farmed regions.

b.1. Distribution

Soils typically encountered in the study area are predominantly colluvial in nature. Soil associations are shown in Table III.B-1 for the study area. These associations/complexes are typified as occurring on steep side slopes of higher mountains and formed on residuum or creep material from acidic sandstone, siltstone, and shale. These soils are very thin, with a typical topsoil layer of only 0 to 3 inches over varying amounts of colluvial material/subsoil ranging from 1.5 to 5 feet thick before reaching bedrock. These thin steep side hill colluvial soils' productivity and erodability can be increased and decreased, respectively, with proper planning. The presence of deeper colluvial and residual weathered deposits on southwest slopes that face the prevailing weather patterns make the region susceptible to land slides. A dominant land use in parts of the study area is forestry, which, depending on if and when it was last harvested, may have adversely affected the thickness of the topsoil layer.

Table III.B-1
Summary of Major Soil Associations in the Study Area

State	Hydrology Area Number	Primary Soil Associations
West Virginia	9	Clymer-Dekalb-Jefferson
West Virginia	9	Dekalb-Gilpin-Ernist
West Virginia	9	Gilpin-Ernist-Buckhanon
West Virginia	9	Clymer-Gilpin-Upshur
West Virginia	9	Gilpin-Dekalb-Buckhanon
West Virginia	12	Clymer-Dekalb-Jefferson
West Virginia	12	Clymer-Gilpin
West Virginia	12	Clymer-Gilpin-Upshur
West Virginia	13	Clymer-Dekalb-Jefferson
Kentucky	13	Jefferson-Shelocta
Kentucky	13	Dekalb-Berks-Weikert
Kentucky	14	Jefferson-Shelocta
Kentucky	14	Lathan-Shelocta
Kentucky	14	Jefferson-Dekalb
Kentucky	15	Jefferson-Shelocta
Kentucky	15	Lathan-Shelocta
Kentucky	15	Jefferson-Dekalb
Kentucky	15	Shelocta-Gilpin
Tennessee/ Kentucky	17	Muskingum-Gilpin-Jefferson/ Lathan-Shelocta
Tennessee/ Kentucky	17	Ramsey-Hartsells-Grimsley-Gilpin/ Jefferson-Shelocta
Tennessee	18/20	Ramsey-Hartsells-Grimsley-Gilpin
Tennessee	18/20	Muskingum-Gilpin-Jefferson
Virginia	13/16	Berks-Pineville-Rock Outcrop
Virginia	13/16	Kimper-Shelocta-Hazelton
Virginia	16	Berks-Weikert-Ladig
Virginia	13/16	Wallen-DeKalb-Dry Pond

State	Hydrology Area Number	Primary Soil Associations
Virginia	13	Jefferson-Wallen-Gilpin
Virginia	13/16	Fredrick-Carbo-Timberville
Virginia	16	Groseclose-Litz-Shottower
Virginia	16	Mommaw-Jefferson-Alonzville
Virginia	16	Murrill-Westmoreland-Frederick
Virginia	16	Carbo-Chilhowie-Frederick
Virginia	16	Catache-Berks-Shouns

source: http://www.va.nrcs.usda.gov/soils

Not appearing on Figure III.B.1 are the narrow bands of valley soils along the flood plains, which are both colluvial and alluvial in nature. The unconsolidated materials forming these soils can range from a depth of 5 feet along narrow streams to100 feet along large rivers. The soils in these locations often are inceptisols showing only limited horizonation. These soils are typically very productive and can qualify as prime farmland soils.

4. Soil Productivity

This portion of the environmental impact statement (EIS) addresses soil quality and forest productivity at reclaimed mountaintop mine sites and is based on a technical study performed by OSM to support the EIS. This study involved collecting available published literature, papers presented at conferences and symposiums, interviews with prominent researchers, and documenting the collective knowledge and experience of the Soil Quality and Forest Productivity team members.
Several milestones were identified in the work plan and accomplished as shown:

1) examine soil properties--evaluated on the basis of the literature and team experience
2) evaluate the effectiveness of current sampling and testing protocols--evaluated on the basis of the literature and team experience
3) establish the effectiveness of current reclamation methods--dropped from consideration as inappropriate within the study time frame
4) evaluate long-term indices for determining forest productivity on reclaimed mined lands--evaluated on the basis of the literature, team experience and interviews with researchers
5) interview prominent researchers--accomplished
6) review regulations--accomplished
7) determine which factors limit tree production on mined lands--accomplished
8) conduct field verification of site conditions if the information gathered warrant such investigations–this task was not warranted, given the experience of the team

The study report outline is based on the activities described above. Four major topic areas were identified:

1) Review and identify applicable regulations--This is not simply a restatement of the regulations, but an assessment of whether the rule has positive or negative effects on the reclamation of mined lands;
2) Mine soil forest relationships–A technical perspective on different mining techniques use to create a growth media conducive to reforestation;
3) The third topic deals with the effect of mycorrhizal relationships on planting stocks–Evidence supports inoculating tree stock with mycorrhiza in order to improve the growth and survival of planted trees. Other researchers argue that native organisms found in topsoil are important to tree growth. The study will look at this issue and report the results;
4) The fourth topic is about planting trees on mined lands. Here again, the idea is to extrapolate from existing literature a brief description of the state-of-the-art, risks, hazards, and probable replanting rates in an attempt to identify changes that could be implemented to encourage planting of more trees.

There are also other factors that influence tree planting on mined lands that will only briefly be mentioned here. The stability of growth media placed on backfill must be considered when selecting reclamation techniques. Although this factor deals with topsoil/substitute placement, it is more of an engineering issue. Cost is another consideration that will have a great influence on whether or not changes will be made that allow increased, more effective tree reclamation to occur on mine sites. The challenge is to find more cost effective ways to create new forest on mined lands.

a. Applicable Regulations and Observations on Implementation

SMCRA, OSM regulations, and state regulations (which must be as effective as OSM regulations), contain elements that may work at cross purposes. For example, when regulatory authorities strictly enforce erosion control regulations as a means of protecting water quality, there is a strong tendency for operators to use quick-germinating, vigorously-growing grasses and legumes to stabilize the soil and prevent erosion. Such vigorous herbaceous vegetation, however, has the unfortunate side effect of discouraging tree establishment. Additionally, in most of Appalachia, grass and legume stabilized areas are considered adequately vegetated to meet the requirements for the pasture land use. Thus, an operator could obtain bond release without further revegetation work. A further disincentive to reforestation is the fact that grass/legume mixtures commonly used in reclamation tolerate a wide range of soil chemical conditions, as well as the excessively compacted soils, that typify reclamation in Appalachia. Thus, the use of grasses and legumes serves as the low cost, low-risk option for bond release. Even when the reclamation plan calls for the planting of trees, excessive compaction of the rooting medium, which severely reduces tree growth, is the norm.

The following sections use West Virginia soil handling regulations to illustrate barriers to effective reforestation. The other steep slope Appalachian regulatory programs contain similar provisions but, for brevity, will not be restated here.

38CSR2.14.3 Topsoil

14.3a. Removal. Prior to disturbance of an area, topsoil shall be removed from the area to be disturbed in a separate layer and if not immediately redistributed, it shall be segregated and stockpiled in a separate stable location as specified in the preplan. Stockpiled topsoil shall remain in place until used for redistribution unless otherwise approved by the Director. Stockpiled topsoil shall be protected from excessive compaction. Where the removal of vegetative material, topsoil or other materials may result in erosion, the Director may limit the size of the area from which these materials are removed at any one time.

Historically, Post Mining Land Uses (PMLU)in the mountaintop mining area of West Virginia were predominantly grasslands, which led to the soils rarely being salvaged. The soils were generally characterized by permit applicants as too thin and/or too poor in quality to justify salvaging for the PMLU.

14.3.b. Redistribution. Prior to redistribution of topsoil, the regraded land shall be treated, if necessary, to reduce the potential for slippage of the redistributed material and/or to enhance root penetration. Topsoil and other materials shall be redistributed in a manner that prevents excess compaction and that achieves an approximate uniform, stable thickness, consistent with the approved postmining land uses, contours, soil density, and surface water drainage system. Immediately after redistribution all topsoil areas shall be protected from wind and water erosion.

Excessive compaction is a well-known impediment to revegetation in Appalachia and other coal regions of the country. As noted above in 14.3.b, the conflict between not over compacting soils and stability or soil erosion is a concern. That is, soil and soil substitutes are often compacted to the point of seriously reducing root penetration when the objective is to maximize stability or reduce erosion of those soils. The negative impact of this compaction on biomass production is greater for trees than for grasses and legumes.

14.3.c. Top Soil Substitutes. Any substitute material used for top soiling must be capable of supporting and maintaining the approved postmining land use. This determination of capability shall be based on the results of appropriate chemical and physical analysis of overburden and topsoil. These analyses shall include at a minimum depth, thickness and areal extent of the substitute structure or soil horizon, pH. Texture class, percent coarse fragments and nutrient content. A certification of analysis shall be made by a qualified laboratory stating that:

14.3.c.1 The proposed substitute material is equally suitable for sustaining vegetation as the existing topsoil;

14.3.c.2. The resulting soil medium is the best reasonably available in the permit area to support vegetation;

14.3.c.3. The analyses were conducted using standard testing procedures.

14.3.d. Soil Amendments. Nutrients and soil amendments in the amounts determined by soil tests shall be applied to the redistributed surface soil layer so that it supports the approved postmining land use and meets the revegetation requirements of Section 9 of this rule. These tests shall include nutrient analysis and lime requirement tests. Results of these tests shall be submitted to the Director with the final planting report as required by this rule.

In practice, selective overburden handling in the mountaintop mining area of West Virginia is conducted so as to prevent the deposition of acid toxic materials on the surface. The predominant PMLU has included a bias towards salvaging fine-textured, high pH soil materials that provide favorable chemical conditions for the growth of grasses and legumes, but have a negative impact on forest regeneration.

Approval for use of a topsoil substitute material requires a waiver, as described in 14.3.c above, and must support the PMLU. Most permits requesting the use of a topsoil substitute will indicate thin soils [III.B.1] as a reason for not saving topsoil. The permit will explain, using language something to the effect that "slopes are steep with only a thin layer of topsoil that would not be practical to save following clearing and grubbing." Furthermore, the permit will state that "the quality of the topsoil is poor with very little capacity for supplying plant nutrients." This may provide poor soils for grasses and legumes, but support a mixed hardwood climax forest. What is described as poor for one land use may be ideal for another land use.

Topsoil has nearly all of the living matter that makes the collection of sand, silt, and clay a living soil capable of sustaining plant life. It is not just soil pH and nutrients that makes a medium suitable for plant growth and development. This is the reason why the surface mining act and State regulations at 38CSR2.14.3.a. require the saving of topsoil. Recognizing that all topsoil is not created equally, topsoil substitutes are permissible, provided the new material can be shown to be as good as or better than the original topsoil.

The West Virginia surface mining law, at §22-3-10.(2)(B), and other steep slope state counterparts require an evaluation of the land's capability to support a variety of uses prior to any mining. §22-3-10.(3) and other states' similar provisions require that, relative to mined land use following reclamation, the permit include a discussion of the utility and capacity of the reclaimed land to support a variety of alternative uses.

b. Mine Soil/Forest Relationships

Prior to the passage of SMCRA, most surface-mined land in the east and midwest was reclaimed with trees. The quality and productivity of these lands varied, but, in general, reforestation was successful, and commercially valuable forests were created (Andrews et al., 1998). With the implementation of SMCRA-based rules and regulations, the percentage of land reclaimed to forest dropped significantly. The rules, as typically interpreted and enforced, resulted in intensely-graded landscapes with erosion control provided by herbaceous vegetation. In this post-SMCRA environment, reforestation was difficult and productivity of those lands reforested was disappointing.

The reclamation literature, extending from well before the passage of SMCRA, up to the present, presents a clear picture of the factors responsible for the success or failure of reforestation efforts. OSM has recently initiated a program to promote reforestation and eliminate regulatory barriers to establishing trees on reclaimed sites. The goal is to create a regulatory process that will result in successful reforestation; that is, result in the establishment of forests that are productive and economically viable for timber production.

Deep rocky soils with the appropriate chemical composition can be produced through mining and reclamation, and will support forests that are more productive than those supported by the thin natural soils typical of the Appalachian mountains. However, the mine soils that support good forest growth vary chemically over a more limited range than those that will support a good stand of herbaceous vegetation. Trees also are more sensitive than herbaceous vegetation to the negative impacts of excess compaction.

Ashby et al., 1984, states that "mine soils with differing contents of coarse fragments may have productivity equal to or greater than pre-mining soils." Indeed, a relatively small percentage of soil fines distributed through a matrix of rocky material that is not excessively compacted can function as an excellent substrate for tree growth. The "increased rooting depth on loose mine soils appears to compensate more than adequately for loss of soil volume due to stones." Additionally, appropriately constructed mine soils may have higher water infiltration rates and lower erosion rates than replaced soils. Ultimately, it is the water and nutrient supplying capacity of the rooting medium that translates into plant productivity.

Research in Appalachia on reforestation of mined lands in the post-SMCRA environment portrays the actual accomplishments and has assisted in refining the requirements for mine soils that will support productive forests. The productivity of mine soils produced post-SMCRA is characteristically reduced by excessive compaction. These soils may be further reduced in value for forest growth due to lack of selection of appropriate substrate materials or selection of fine textured materials with a high pH (which are more favorable for supporting herbaceous vegetation). However, the technology exists to produce high-quality forest soils. Burger, et al., 1998 describe this technology and identify policies designed to encourage its use. They state:

> Research by reclamation forestry groups throughout the Appalachian and Midwestern coalfields has shown that productive mine soils and forests can be restored by using a "forestry reclamation approach," described in Virginia Cooperative Extension (VCE)

Publications 460-123 (Burger and Torbert, 1992) and 460-136 (Torbert et al., 1994). The forestry reclamation approach basically entails:

1. Replacing 3 to 4 feet of surface soil and/or weathered, sandstone overburden (taken from the surface 10 feet) for the new reclaimed soil and sub-soil medium;

2. Loosely grading noncompacted topsoil or topsoil substitutes that include, when possible, woody debris and native seeds;

3. Using native and non-competitive domestic ground covers (tree-compatible) that quickly protect the site, encourage native forest plants and animals, and enhance forest succession; and

4. Planting nurse trees for wildlife and mine soil improvement, and planting valuable crop trees for their commercial value to the landowner and adjacent communities.

This forestry reclamation approach has been used operationally and has proven successful. In addition, the approach described above can cost the mine operator $200 to $500 less per acre than traditional reforestation practices, due to reduced grading costs and less expensive ground cover seed mixtures. This approach has been approved by the Virginia Department of Mines, Minerals, and Energy in a July 9, 1996, memo on reforestation guidelines. Approximately 80% of Virginia's operators/landowners are now opting for a post-mining land use of forestry. New reforestation reclamation guidelines have also been approved as a reforestation initiative by the Kentucky Department for Surface Mining and Reclamation and Enforcement in Reclamation Advisory Memorandum #124 (KY DSMRE, 1997). In West Virginia, this approach is consistent with regulatory agency criteria for approving reclamation plans to achieve a forestry post-mining land use.

Foresters judge soil quality based on the average height of trees at a given "index age," such as trees of age 25 or 50 years. Site index has a dramatic effect on the value of timber produced (Burger, et al., 1998). In Table III.B-1, reclamation technique is related to white pine productivity and stand value at 30 years.

c. Effect of Site Index on Timber Value: Oak

White pine was used in the analysis shown in Table III.B-1 because of its predominant use on post-law mined land. Although total wood volume would be less for hardwoods, the same general relationships between site quality and value per acre would hold true. A site with a white pine site index of 55 (age 25) has an average oak site index of 65 (age 50), which is an average value for oaks across most of the Appalachians. This species-to-species relationship shows that average post-SMCRA reclamation site quality for oaks would be about 50, and the site quality potential for oaks of properly-reclaimed mine sites would be about 85. This estimate is confirmed by Ashby, *et al*. (1984) who evaluated mine soil productivities for oak species.

Table III.B-2 shows the relative influence of soil and site properties on oak site index, wood yield, and harvest value. Average oak sawtimber value at age 60 on average quality sites (SI = 65) is about $4,250 per acre. If forest sites are degraded through typical post-law reclamation from SI 65 to 50, potential harvest value becomes one-fourth of what it was originally. If sites are upgraded through reclamation to SI 85, harvest value doubles. These estimates show the dramatic effect site quality has on forest land value and, it shows why landowners and the mining community should strive for proper reclamation of forest land.

Table III.B-2
The Effects of Reclamation Technique on White Pine Productivity and Stand Value at 30 Years

Case	White Pine Site Type	Site Index* (Base Age 25)	Bd.Ft.Vol. at Age 30 (MBF/ac)**	Harvestable Wood Products	Harvest Price ($/MBF)	Total Value ($/acre)
I	Average quality of an undisturbed Appalachian forest site (Doolittle 1958)	55	35.1	small sawtimber	50	1,755
II	Projected average quality of a post-SMCRA reclaimed mine soil (Torbert et al., 1994)	45	6.1	pulp	20	122
III	Actual quality of a white pine stand on a good minesoil in Virginia (Kelting et al., 1997)	70	46.4	large sawtimber	75	3,480

*Site Index = Expected tree height after 25 years.
** Board Foot Volume at Age 30 (MBF/acre). MBF = thousand board feet (Vimmerstedt, 1962).

Table III.B-3
The Relative Effect of Site Quality on Appalachian Oak Harvest Volumes and Stumpage Value at Age 60

Site Index	Appalachian Oak Site Index (ft) (Base Age 50)	Bd.Ft.Vol. at Age 60 (MBF/ac)*	Harvestable Wood Products	Stumpage Price ($/MBF**)	Total Value ($/acre)
Average	65	11.8	sawtimber	360	4250
Poor	50	5.6	small sawtimber	200	1120
Good	85	16.2	large sawtimber, veneer	520	8425

*MBF = thousand board feet (Schnur, 1937)

The information in Table III.B-2 is corroborated by the experience of reclamation personnel and is reflected in West Virginia's recently proposed commercial forestry regulations. In estimating the likely quality of reclamation to be obtained under these regulations, we must recognize the fact that the current regulations (which have been in place since May 16, 1983) require that selected overburden substitutes for soil be "equal to, or more suitable for sustaining vegetation than the existing topsoil, and the resulting soil medium is the best available in the permit area to support revegetation." Also, soil materials are to be redistributed in a manner that prevents excessive compaction of the materials. Be this as it may, the reality of reclamation in Appalachia is that selective overburden handling is rarely practiced beyond that required to keep highly toxic material out of the rooting zone; excessive compaction is commonplace. Andrews, et al, 1998, point out that "Height growth was greater on steeper slopes. In naturally-forested stands the opposite is usually true, because steeper slopes have greater runoff, shallower soils, and more erosion. On reclaimed sites, slope steepness is related to depth and compaction. Level sites are often subjected to greater vehicle traffic, resulting in more compaction and poorer drainage and aeration."

Production of soils that will support commercial forestry as part of mountaintop mining requires selective overburden handling and replacement procedures on a scale that has never been carried out in Appalachia. Full-mine scale replacement of native soils without excessive compaction does occur however. Replacement of native soils without excessive compaction in area mining operations, or with reduction of excessive compaction by ripping, is standard practice where prime farmland is reclaimed.

d. Soil/Overburden Chemistry

Andrews, *et al.*, 1998, found that the most important chemical factor influencing the growth of white pine was soluble salts. The second-most important soil chemical property affecting white pine growth was extractable phosphate, and in general, height growth declined when exchangeable manganese levels exceeded 20 mg/kg. Site requirements for different species of trees vary widely, and there is ample opportunity to further refine the site requirements for different tree species used in reforestation. However, from a practical standpoint, it is probably adequate to reconstruct the soil medium by salvaging material from the top 10 feet of overburden. On average, this will result in a soil medium with an adequate chemical composition and with adequate microbial inoculum from the native soils.

Burger et al., 1998, address the practical aspects of re-establishing productive forests in Appalachia, stating:

> "Our work shows that, in nearly all cases, any mix of the surface 10 feet of soil and rock makes an excellent growth medium for virtually all native species of pines and hardwoods. Applying 4 feet of this mix of material without compaction creates a topsoil substitute that is usually as productive or more productive than the original soil. Woody debris and some rocks mixed in or laying on the surface actually create microsites for native species. Less grading and seeding is needed for forestry land uses, making the use of this topsoil substitute cheaper for the mine operator."

e. Soil Compaction

Compaction of mine soils is identified as one of the chief factors reducing the value of reclaimed forest lands. We are not aware of any research on the effect of natural forces such as freezing and thawing and root action on improving compacted mine soils. However, with the increase in the size of agricultural equipment and the advent of "no till" agriculture, there has been increasing attention given to the effect of compaction on agricultural soils. Research on soils that are subject to freeze-thaw cycles during the winter and root action from crops or native and introduced grasses suggests that compaction below the plow layer may persist a century or more (Sharratt, *et al.*, 1997; Kay, *et al.*,1985; Voorhees,1983; Sharratt, *et al.*, 1998; and, Blake, *et al.*, 1976). In spite of the lack of systematic data addressing the impact of natural forces and tree roots on the compaction of mine soils, it is prudent to assume that compacted mine soils, with their well documented detrimental impact on tree growth, will behave similar to agricultural soils with compaction enduring over similar periods of time.

f. Mycorrhizal Relationships

Mycorrhizae have been widely reported to aid survival and growth of forest trees under many different site conditions (Ruehle and Marx, 1979) (Parkinson, 1978) (Danielson, *et al.*,1978). *Pisolithus tinctorius* (Pt.) was found to improve the survival and growth of pine seedlings on acid coal mine spoil by Marx and Artman (1979). Schoenholtz and Burger (1984) found that inoculation with this same fungi enhanced seedling growth to some extent, but high amounts of natural ectomycorrhizal colonization probably masked some of the effects of Pt. Cordell and co-workers (1999), indicated that specific mycorrhizal fungi provided significant benefits to the plant symbionts on drastically disturbed mine sites through increased water and nutrient absorption, decreased toxic materials absorption, and overall plant stress reduction. Other researchers have contributed to the body of knowledge concerning the effects of surface mining on soil microbial communities and algal colonization and succession (Visser, *et al.*, 1978) (Starks and Shubert, 1978) (Shubert and Starks, 1978).

The role of mycorrhizal fungi in sustaining productive forests on more favorable mine sites has also been well documented. When a readily available source of nutrients are present, seedlings would not be expected to benefit nutritionally from mycorrhizae. Marx (1977) determined that loblolly pines with roots that are growing rapidly due to high soil fertility have a decreased sucrose content and are not susceptible to ectomycorrhizal infection. Also, Torbet, *et al*. (1985) found that mycorrhizae did not have an effect on seeding growth in spoil material that had a high soil fertility. This study also determined that mycorrhizal trees not planted with a fertilizer pellet had significantly greater volumes due to enhanced diameter growth; however, fertilized non-mycorrhizal seedlings in rock mix spoils had greater heights, diameters, and twice the volume of non-fertilized infected trees in spoils with surface treatments.

The influence of pH on mycorrhizal fungi has had substantial investigation. It has been demonstrated that conifers are better adapted and are more productive on somewhat acidic soils (Pritchett, 1979). Part of this adaptation has to do with their symbiotic association with mycorrhizal fungi, which play a significant role in the rhizosphere of conifers (Marx, 1977). Theodorow and Bowen (1969) reported that most ectomycorrhizae associated with conifers do not thrive when the soil pH exceeds 6.5. This was confirmed in a study on minesoils by Schoenholtz et al. (1987) when the rates of colonization of mycorrhizal was compared for three pine species growing in two different spoils with pH values of 5.4 and 6.1, respectively. Numbers of trees and numbers of short roots per tree colonized were consistently higher at the lower pH. The colonized trees survived and grew better. Torbet and co-workers (1990) also found that there was a distinct inverse relationship between pine growth and mine soil pH which they attributed in part to the symbiotic association with mycorrhizal fungi.

Although more recent studies generally acknowledge the benefits of mycorrhizal inoculation, there has been caution to portray it as a panacea for revegetation problems on surface mine spoil. Torbert and Burger (1990) advised that their studies show that when a site is properly reclaimed and revegetated, virtually any tree species suitable to the climate can be established without the need for containerized seedlings, mycorrhizal inoculation, fertilizer tablets, or chemical weed-control. And in keeping with this same theme, Burger (1999) concluded in a research summary that on one study site, "After 2 years, all seedlings were colonized by native mycorrhizae. Special mycorrhizal treatment was not necessary; there was no difference in survival and growth between treated and untreated seedlings."

g. Planting Trees on Mined Land

Establishment of trees on surface mined lands has been documented for at least 50 years. Changes in the mining industry in recent years or, more to the point, changes in the methods of reclaiming mined lands have been responsible for the poor results on areas reclaimed to forest lands. As the poor results became apparent, a number of researchers began a quest for solutions to the problem. Among the leaders in this research were Dr. Don Graves of the University of Kentucky and Dr. James Burger of Virginia Tech. Their contributions to the research of reforesting mined lands have been prolific and have followed parallel lines. Both Graves and Burger were also intimately involved in the development of a document designed for the state of Kentucky to address the problems of reforestation on mined lands. The goal of the guidance document was not simply to get trees to survive on mined land, but to provide an environment in which they could thrive. Much of what is known today regarding reforestation of mined lands has been brought together in the Kentucky guidance document.

The document, called Reclamation Advisory Memorandum (RAM) #124, was developed with the assistance of coal industry officials, educators, environmental leaders, forestry and wildlife officials, and federal and State mine regulators from Kentucky. Most current reforestation literature was reviewed and utilized in producing this guidance document. It was published March 10, 1997. The following summation of RAM #124 is essentially a summary of the state of the art of tree planting on mined lands in the eastern portion of the United States.

Successful tree planting is not measured by numbers of living stems per acre but by the potential of those living stems to produce "crops" of recreation, wildlife, lumber and other values associated with forested lands. RAM #124 was developed to enhance the potential for mined lands to produce viable, productive stands of commercial timber. Associated values are likewise increased by proper site preparation of mined lands. The RAM identified three practices that inhibit the establishment of productive stands of timber. They are:

1) excessive compaction of the surface 4-6 feet;
2) selection of inappropriate rooting medium; and
3) excessive competition from herbaceous ground cover.

Conversely, the RAM identified three practices that, if followed, could promote tree establishment and growth. They are:

1) minimal grading of level to gently sloping areas;
2) use 4 - 6 feet of slightly acidic to near neutral rooting medium;
3) and selection of less intrusive species for erosion control.

The RAM addresses each limitation with guidance to avoid certain practices and establish productive practices in their place.

Excessive compaction constructs a limited rooting zone, resulting in poor root penetration, along with poor survival and reduced growth. To achieve minimal compaction, it is recommended that end-dump equipment be used to place the rooting medium in tightly placed piles. The surface is then graded by low ground pressure equipment to grade the tops of the piles and gently level the area in one or two passes. Areas utilizing drag lines are advised to similarly place material in order that grading can be accomplished in 1 or 2 passes with a tracked dozer. Steep slope operations (over 27 degree slopes) are advised to end dump material that has had large boulders removed on the outslope and grade in one or two passes.

Limited topsoil and the erosiveness and compacting qualities of topsoil often make it desirable to utilize an alternate material as a growing medium. Growth medium with low to moderate levels of soluble salts, low pyritic sulfur content, pH levels between 5.0 to 7.0, and texture conducive to proper internal drainage should be selected. Revegetation species should be selected that are compatible with the soil pH, with consideration for the wide range of acceptable pH and limited range of optimum pH for tree species.

Excessive competition from ground cover has had a negative impact on establishment of tree stands on mined lands due to the use of aggressive species such as fescue and excessive fertilization designed for herbaceous vegetation . Selection of ground cover should be based on soil pH and the growth habit of the species. Slow growing ground cover species insures soil stabilization while allowing tree seedlings to emerge above the ground cover, ensuring their survival.

Attention to these factors and practices, along with controlled fertilization is recommended by this State RAM in order to achieve establishment and good growth of timber stands on mined lands. One aspect of tree establishment that literature addressed but that was not addressed in this RAM is the effect of mycorrhiza on tree establishment and growth. Dr. Burger stresses the use of the top10 feet of soil and rock as the growing medium in his studies, providing natural inoculation with mycorrhiza. The RAM however did not strictly adhere to that recommended practice. It did however recommend the inoculation of seedling stock.

Reforestation is also subject to risks caused by the vagaries of the weather, browsing damage, girdling by mice and improper handling and planting of nursery stock. These risks have tended to discourage the choice of reforestation as a land use option by coal operators. However, these risks may be more than offset by the potential for reduced costs when the reduced grading required for successful reforestation is factored in.

5. Topography and Geomorphology

Topography describes the actual shape of a land form, while geomorphology is the study of the characteristics, origin, and development of a land form. Topography is a very important factor in determining the extent and practicality of coal mining on a given site, and the nature of its excess spoil disposal requirements. Steep-sloped, deeply incised topography as found in much of Tennessee and West Virginia, exposes many coal seams to access by surface mining methods, but limits the practical return of spoil to mine benches. Shallower geomorphology and less coal seams does not expose as many coal seams to surface access. Underground mining is not as strongly influenced by topography, but it is favored by incised lands that allow ready access to the outcrops of coal seams deeper in the geologic formation. This section provides background on the topographic and geomorphic setting of the study area to aid in understanding the influences that these features have on the mining activities discussed in other portions of this EIS.

a. Topographic Characteristics

The study area is characterized by steep slopes and narrow valleys. Several areas within the study area have steep river gorges. However, there are areas within the study area that have rounded hilltops, stream terraces, and floodplains near large rivers. Level stream terraces and wide floodplains along rivers and some tributaries provide areas of nearly flat land. Gently sloping plateau areas are interrupted and dissected by numerous rivers and streams with steep valley slopes in portions of the study area. The majority of the study area can be characterized by consecutive ridges with slopes greater than 20° and only a few small, rounded hilltops. Many portions of the study area have mountain peaks greater than 1,969 feet (600 meters). Elevation is depicted in Figure III.B-2.

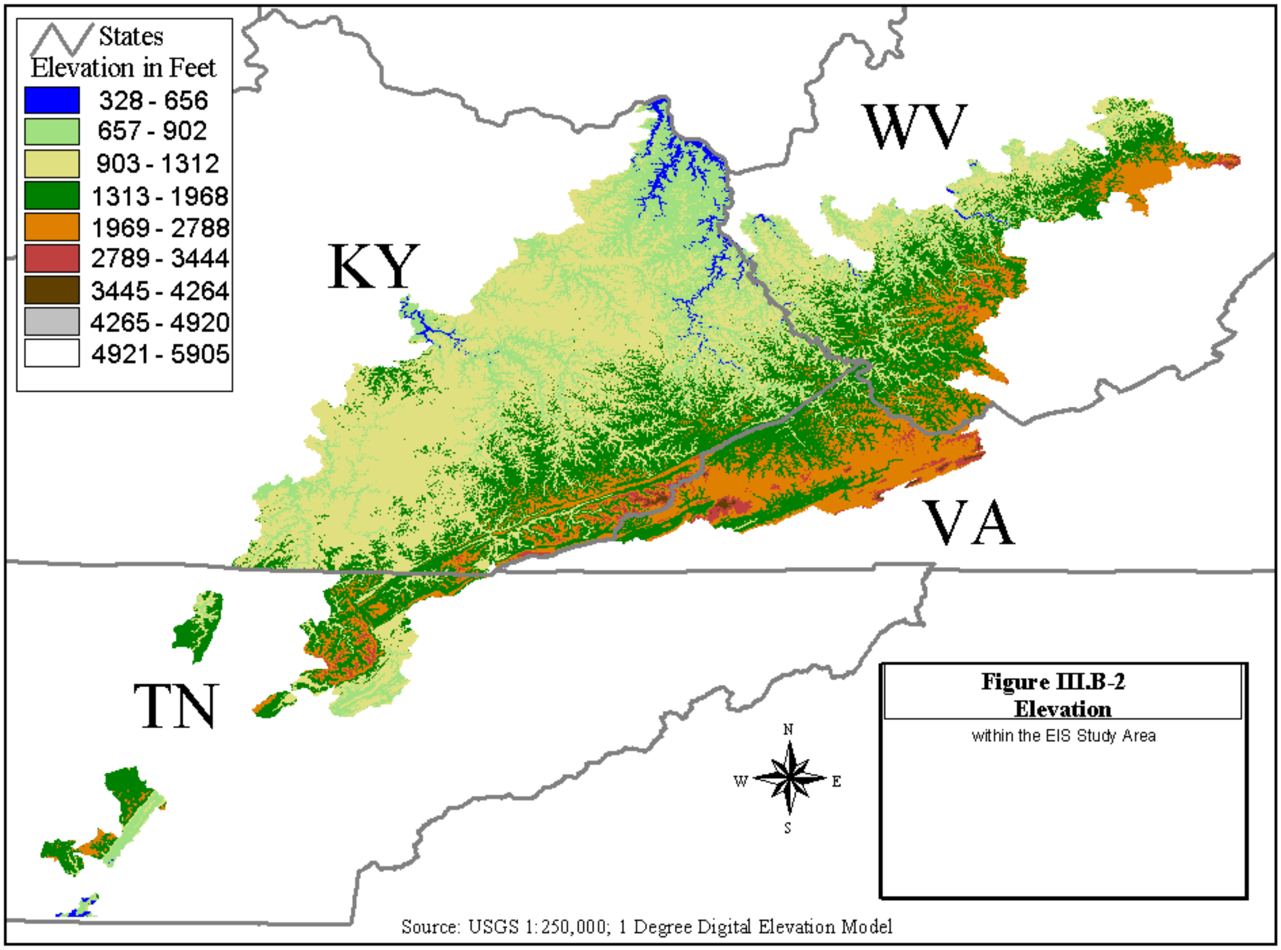


Figure III.B-2 Elevation

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b. Geomorphic Characteristics

After the mountain-building phase of the Appalachian orogeny, the study area experienced a long period of erosion stretching into the Miocene epoch. Most of the Appalachian Highland region is believed to have been beveled flat, as evidenced by the long ridge crests of equal elevation in the Valley and Ridge Province. After the Miocene, a regional uplift of undetermined origin elevated the modern Appalachian Mountain region to its approximate existing peak elevations. Rejuvenated erosion then carved into the elevated strata primarily along zones of structural or bedrock weakness. In the Ridge and Valley Province, the soluble limestone cores of breached anticlines eroded to form long, gently curving valleys, while in the Appalachian Plateau Province erosion along fracture trends was favored, forming dendritic and trellis stream patterns. The original drainage patterns of some large, pre-uplift rivers were preserved during the uplift and cross structural trends. The Susquehana River Valley is an example of such a superimposed drainage pattern. Other prehistoric drainage patterns have been abandoned over time, usually by significant drainage pattern changes occurring during glacial periods.

The ancient Teays Valley trends east-west across the lower Appalachian Basin. Prior to the Pleistocene Period (2.5 million years ago), the Teays River flowed westward across Virginia and West Virginia along a course presently occupied in part by the New River and Kanawha River systems. The Kanawha River follows the course of the pre-glacial Teays River upstream from St. Albans. The geologic history of the abandonment of the Teays River Valley west of St. Albans is poorly understood or documented. Today, the sediments of the former Teays River and its tributaries reach an elevation of nearly 800 feet (244 meters) within the former stream valley. The fine sand, silt, and clay within the sediments average 20 to 30 feet (6 to 9 meters) in thickness and may increase to a thickness of greater than 59 feet (18 meters) locally. These sediments serve as important aquifers for residential, industrial, and municipal use.

c. Steep Slopes and Slope Stability

The most significant topographic controls on surface mining activities within the study area are the steep slopes that are prevalent in the Appalachian Plateau Province. The slopes control both the volume and stability of excess material placement during filling. Steep slopes are the places where the mass movement of earth material is most likely to occur following mining or other disturbances. Landslides along highways are generally most common where slopes range between 20 percent and 35 percent (Hall 1980, Lessing et al., 1976). In many areas, more severe slopes already have been stabilized through slides and other earth movements, whereas these lesser slopes (20 percent to 35 percent) remain unstable and sensitive to mine-related disturbances. The regulations interpreting the Surface Mining and Reclamation Act (SMCRA) define steep slope as any slope of more than 20 degrees, or a lesser slope as may be designated by the regulatory authority of a state.

SMCRA regulations contain permitting, design, and construction monitoring requirements intended to implement state-of-the-art engineering standards for excess spoil disposal. The regulations and engineering standards are tailored to ensure meeting the SMCRA goals of long-term stability, public safety and environmental protection. To perform a retrospective study definitively evaluating the mass stability of large earth and rock structures requires intimate knowledge of representative shear strength parameters of the fill and foundation material, as well as definition of the phreatic surface within the fill. With reliable excess spoil, geotechnical strength parameters and internal pore water pressure information (along with the dimensions of the fill, foundation, and bedrock) a stability analysis can provide accurate engineering estimates for the factor of safety of the fill. Various state regulatory programs routinely evaluate the company submission of this type of information in permits, evaluate the adherence to approved plans in monthly inspections, and assess the fills for signs of incipient or actual failure prior to making bond release decisions after construction. Company engineers and consultants perform extensive tests, stake their professional reputation and licenses on fill designs, document/certify critical construction phases, and attain certification quarterly. Valley Fill stability is discussed in Section III.K.

d. Unstable Slopes

Generally, most slope failures are confined to the thin layer of soil, colluvium, or weathered rock that develops on the steep valley slopes. Rockfalls are usually associated with the excavation activities of man, but they also may occur on natural cliff faces where meandering streams erode soft rocks that underlie more resistant sandstone bluffs. Any construction activity that involves: removal of vegetation, increased loading on the slope, undercutting the slope, or alteration of the hydrologic balance (surface water and groundwater), may induce slope failure. Coal mining and its related activities commonly involve all of these. Other factors that increase the potential for slope failure are as follows:

- Bedrock Factors - For example, the red shales of the Monongahela and Conemaugh Groups are naturally weak and incompetent. These red shales weather rapidly, especially when exposed, and are the rock type most commonly associated with landslides in West Virginia.

- Soil Factors - Easily erodible soils are thin, clayey soils weathered from shales. These soils are usually on steep inclines, impede groundwater infiltration, and are easily erodible.

- Slope Configuration - Naturally occurring or artificial concave slope configurations concentrate water, that lubricates joints to cause slope failure (Lessing et al., 1976).

Of the landslides studied in West Virginia, 69 percent occurred on concave slopes. In the Coal/Kanawha River Basin, the Muskingum-Upshur association presents a serious landslide hazard on slopes over 20 percent (11°). Muskingum-Upshur, Upshur, Vandalia, and Westmoreland soils also have a high landslide risk, and Brooke soils are moderately susceptible to landslides. The Meckesville, Shelocta, and Wharton series are to a lesser degree subject to slippage. These soils are the known soils to have the highest landslide risk in the Basin (Cardi et al., 1979). In the state of West Virginia the following soil series are susceptible to landslides: Brooke, Brookside, Clarksburg, Culleoka, Dormont, Ernest, Guernsey, Markland, Upshur, Vandalia, Westmoreland, Wharton, and Zoar. These soils are considered to be slide prone due to soil characteristics, percent slope and other variables.

Long, continuous precipitation events or sudden heavy rains may reduce the shear strength of soils and colluvium and load these materials sufficiently to produce landslides on steep dip and talus slopes. During coal mining on 25 percent to 36 percent slopes, spoil placed on the downslope, even temporarily, is highly susceptible to slope failure, especially during the spring rainy season (Lessing et al., 1976).

6. Climate

The climate within the study area is temperate and is favorable for many types of plants and animals. Generally, summers are warm and humid with winters moderately cold. Valleys can have lower temperatures than the surrounding hills when cooler heavier air drains to areas of lower elevations. Precipitation is fairly well distributed throughout the year. Seasonal temperatures, rainfall, snowfall, wind, and humidity differ from West Virginia, Kentucky, Tennessee and Virginia. An approximate average of 43 to 50 inches of rain falls on the Kentucky portion of the study area each year. Anywhere from 2 to 5 inches of rain can be expected in any given month. Approximately 52 to 55 inches of rain falls on the Tennessee portion of the study area in the average year. Anywhere from 3 to 6 inches of rain per month can be expected in this area with the wettest months being March and December and the driest month being October. Approximately 84 to 95 days throughout the year will experience greater than 0.10 inches of precipitation.

In the West Virginia portion of the study area, approximately 38 to 50 inches of rain occurs per year. Monthly rainfalls of 3 to 6 inches can also be expected in this area throughout the year. The wettest month tends to be July while the driest months are usually February, October, and November. In the Virginia portion of the study area, approximately 41 to 50 inches of rain occurs per year. Between 2 and 5 inches of rain can be expected in any given month of the year with the wettest months being March, May, and July and the driest month being October. Monthly temperature and precipitation data for each state within the study area are shown in tables presented in Appendix C.

C. APPALACHIAN AQUATIC SYSTEMS

1. Lotic (Flowing) Aquatic Systems

Lotic or flowing aquatic systems are important landscape features in the Mountain Top Mining/Valley Fills EIS Study area. Lotic systems may be considered to include rivers, streams, and creeks and springs. This section will discuss the types, features and functions of lotic systems in the study area.

a. Representative Streams

a.1. Physical Characteristics

Numerous physical parameters such as flow volume, substrate (i.e., the stream bottom made up of cobbles, gravel, sand, etc.), water chemistry, and bank cover influence the biota of the aquatic systems in the study area. These parameters are determined by the climate, lithology, relief and land use in the area of a particular stretch of stream. Many of these factors have been discussed in other chapters of this EIS.

EVEN WHERE INACCESSIBLE TO FISH, THESE SMALL STREAMS PROVIDE HIGH LEVELS OF WATER QUALITY AND QUANTITY, SEDIMENT CONTROL, NUTRIENTS AND WOOD DEBRIS FOR DOWNSTREAM REACHES OF THE WATERSHED. INTERMITTENT AND EPHEMERAL HEADWATER STREAMS ARE, THEREFORE, OFTEN LARGELY RESPONSIBLE FOR MAINTAINING THE QUALITY OF DOWNSTREAM RIVERINE PROCESSES AND HABITAT FOR CONSIDERABLE DISTANCES.

a.2. Stream Classification

Streams are generally classified through a system called stream ordering (Strahler, 1957). This system classifies streams based on size and position within the drainage network. A first-order stream is defined as not having tributaries. The confluence of two streams of the same order produces the next highest order. For example, the joining of two first-order streams results in a second-order stream. The joining of two second-order streams produces a third-order stream, etc. Headwaters are usually classified as first- through third-order streams, mid-sized streams as fourth- through sixth-order streams, and larger rivers as seventh- through twelfth-order streams (Ward, 1992). First order streams in the study area account for approximately 60% of total stream miles as represented by blue lines at the 1:100,000 scale USGS topographic map (EPA Region III June 2000 comments). This classification system can be misleading when just using blue lines on printed maps to indicate stream orders. It is known that there are many more miles of first order streams actually present in the field than appear on most commonly used maps . Therefore, this classification system includes some uncertainty. Stream ordering, though useful in placing a stream reach within an entire stream system, is not necessarily a meaningful description of the physical component of the stream reach itself.

In addition to first-through twelfth-order streams, ephemeral streams and intermittent streams occur in the Appalachian region. Ephemeral and intermittent streams have been defined in various ways depending on the regulatory program. Appendix B of this EIS presents the various definitions.

Generally, ephemeral streams have a discrete channel and flow only in direct response to precipitation events. In contrast, flow in intermittent streams is periodic or seasonal and based on the presence groundwater. Perennial streams are those streams that maintain flow year round. The starting points of the intermittent and perennial streams may vary from year to year depending how wet or dry years have effected the groundwater table. Flow is permanent, but of a relatively low volume in first and second order perennial streams with flow volumes generally continuing to increase with stream order.

a.3. Habitats in Streams

Generally, headwater streams originate at high elevations in the study area. Substrate patterns in headwater streams channels are typically comprised of coarser material such as boulders, cobble rubble and bedrock. Large, woody debris often contribute to the substrate complexity in headwater streams. Small pools with finer sediments may also be found along headwater streams. Typical substrate patterns in larger rivers are comprised of finer material such as silt and sand. Mid-sized rivers typically contain a blend of cobble and gravel with some finer sediment interspersed in areas of slower flow.

Although intermittent streams tend to go dry for a portion of the year, macroinvertebrate life still exists within its channel. In a study of intermittent and perennial streams in Alabama, assemblages of normally intermittent streams did not differ greatly from those of nearby permanent or perennial streams (Feminella, 1996). Data recently collected in conjunction with this EIS (Interagency Invertebrate Study, 2000), suggests similar findings for ephemeral/intermittent streams in the study area. These data show that biological communities in the study area streams are present as soon as there is flowing water. During periods of no visible streamflow, interstitial water flows through the material below the steam. This special hydrology creates a unique habitat, called the hyporheic zone. Specially-adapted macroinvertebrates are able to continue their life cycles by burrowing into the hyporheic zone, especially in times of drought. Other macroinvertebrates live completely within the hyporheic zone (Hynes, 1970).

The combination of substrate characteristics and varying flow rates and other flow characteristics (hydrologic cycles, flow patterns, load transport and storage) produce channel features such as riffles, runs, and pools. Riffles are erosional habitats where surface water flows over coarser substrate, creating turbulence, which causes disturbances in the surface of the water. This turbulence increases levels of dissolved oxygen by encouraging the mixing of oxygen in the air with the water. Pools are depositional areas where flow is slow or stagnant, allowing finer particulate matter to settle onto the stream bottom. Runs are moderately fast sections of streams where the water surface is not as disturbed. Headwater streams, typically consist of alternating riffles and runs though small depositional pools, may be present and represent an important microhabitat. Mid-sized rivers typically contain all three features because increased width and depth allow more variation in flow.

Stream features that are important in determining habitat for aquatic organisms include, overhanging vegetation, the presence and characteristics of leaf packs, in-stream vegetation, large woody debris, undercut banks, and exposed tree roots. Overhanging vegetation consists of riparian shrub and herbaceous vegetation on banks that grows over and sometimes into the surface water. In-stream vegetation occurs where proper substrate and flow conditions allow growth. Snags are pieces of wood that have accumulated in a stream area. Undercut banks and exposed tree roots are caused by a combination of unstable banks and fast streamflow. All of these features provide unique habitat for cover, habitat, and food for macroinvertebrates and fish.

Other in-stream features that provide additional habitat include littoral areas such as shorelines, sandbars, and islands. Typically these features exist most prominently in depositional systems such as larger rivers. These littoral areas are important shallow habitats, which provide habitat for smaller fish and macroinvertebrates that are unable to live in the deeper sections of the river.

Wetlands and riparian zones may occur along streams. Wetlands and riparian zones may influence the physical characteristics of streams, thereby affecting stream habitats. In addition, wetlands and riparian zones may be used by stream biota directly during periods of elevated flow. Wetlands are crucial transition zones between terrestrial and aquatic habitats. They are defined as areas "that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (COE, 1987). Wetlands can be found on floodplains along rivers and streams (riparian wetlands). Typical steep geomorphology of headwater streams usually prohibits the formation of a floodplain, so wetlands are usually restricted to small depressional areas. As the gradient of the land becomes more gradual, more wetlands are found on the floodplain of the stream. Wetlands associated with rivers can take the form of forested wetlands, emergent marshes, wet meadows or small ponds. The unique characteristics and vegetative composition of wetlands provide important habitat for many species of aquatic macroinvertebrates, amphibians, and reptiles.

b. Energy Sources and Plant Communities

Aquatic ecosystem energy sources consist of allochthonous (organic material produced outside the stream such as leaves, wood, etc.) and autochthonous (instream primary production by plants, algae) sources. Allochthonous materials reach the stream either through directly falling into the stream or through indirectly being transported into the stream, commonly though wind movement or runoff. Allochthonous organic material has been found to be the predominant energy source in high-gradient streams of the southern Appalachians (e.g., Hornick et al., 1981, Webster et al., 1983, Wallace et al., 1992). Headwater energy sources are important, not only to invertebrates and vertebrates in upper reaches of the watershed, but, excess organic carbon is subsequently utilized by life forms in all stream orders down gradient. Since streams have a unidirectional flow, downstream areas are also dependent on upstream areas for portions of their energy (Vannote et al. 1980).

Plant communities of high-gradient streams live in what may be considered to be a physically challenging environment. Frequently these habitats are densely shaded and subject to high current velocities. As a result, the plant communities in high-gradient streams are reduced relative to lentic habitats and low-gradient streams (Wallace et al., 1992). However, the plant communities occurring in high-gradient streams contain flora uniquely adapted to survive in this type of environment. This habitat also supports an abundance of flora considered to be endemic (i.e., not found in other locations) to the region (Patrick, 1948). Possibly, the historic lack of direct anthropogenic (human-induced) disturbance to watersheds of high-gradient streams may have contributed to the survival of the unique and endemic flora of this region (Wilcove et al., 1998).

b.1. Vascular Plants and Bryophytes

Vascular plants, such as aquatic macrophytes or ferns, found in high-gradient streams typically have adventitious roots, rhizomes, flexible stems and streamlined narrow leaves (Westlake 1975, Wallace et al. 1992). In contrast, bryophytes (mosses and liverworts,) live closely oppressed to rocks and boulders and are characterized by a small body size. In streams with high turbulent flow, mosses and liverworts have been found to be the dominant group of macrophytes (Westlake, 1975).

b.2. Algae

As summarized in Wallace et al. (1992), the algae of high-gradient streams are limited to species capable of anchoring to stable substrates, preferably large stable objects. Algae may temporarily colonize smaller objects during periods of low flow. The major groups of algae represented in high-gradient streams include red algae (Rhodophyta), filamentous green algae (Chlorophyta), and diatoms (Bacillariophyta) (Wallace et al.1992). Endemic and unique species of algae are common to the high-gradient streams of the southern Appalachians as described in Wallace et al. (1992).

b.3. Primary Production

Primary production is the input of energy into a system by the growth of flora living in the system. In streams, primary production is generally measured as mass of carbon or ash free dry mass, which is largely carbon, per unit area, per year. Primary production rates in Appalachian streams have been shown to vary with stream order, season, degree of shading, nutrients, and water hardness (Wallace et al., 1992). Although under some circumstances, gross primary production can be high (see Hill and Webster 1982b [in Wallace et al., 1992]), typical primary production inputs appear to range from approximately 9 to 446 pounds of carbon per acre of stream per year (Keithan and Lowe 1985, Rodgers et al., 1983, Wallace et al., 1992).

b.4. Allochthonous Energy Sources and Processing

Allochthonous energy sources consist primarily of leaves and woody material. However, dissolved organic carbon (DOC) from a variety of sources is an additional allochthonous energy source. Sources of DOC external to the stream include groundwater or runoff. Sources internal to the stream relate largely to leaching of organic matter from detritus or other organic matter. Fisher and Likens, in Science Applications International Corporation (1998), explain that over 90 percent of the annual energy inputs to small forested streams can be attributed to leaf detritus and dissolved organic carbon from the terrestrial environment. Webster et al. (1995) further discusses sources for organic inputs to streams.

The estimate of almost 3600 pounds of carbon per acre of stream per year developed by Bray and Gorham (1964) as a measure of leaf and wood litterfall into a stream per year, is considered to be a good estimate for input into high-gradient Appalachian streams. The mass of material input as leaf fall is generally greater than that input as woody material. However, in some circumstances the mass of input as woody material may equal that of leaf input (Webster et al., 1990).

Woody Material

In addition to functioning as an energy source, woody material may provide other important stream functions relating to hydrology and habitat structure. These functions may include contributing to stair-step stream bed profiles that result in rapid dissipation of the stream's energy; forming micro-pools or sieve-like structures that retain other particulate organic material, which may influence trophic and nutrient dynamics; providing fish habitat; providing a substrate for some stream invertebrates; and functioning as a food source for wood-eating organisms (Wallace et al., 1992).

Organic Matter Processing

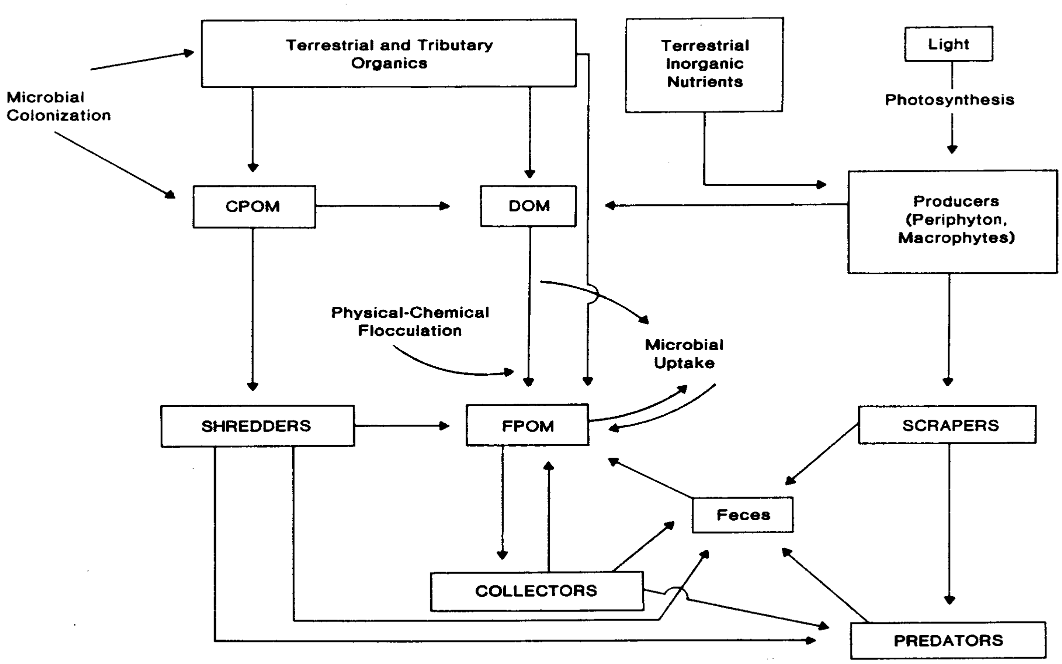
The headwater stream (first- through third-order) is the origin for energy processing within the river ecosystem. Headwater streams in the study area are located in forested areas and are characterized by a heavy leaf canopy and low photosynthetic production. Sources of energy for headwater streams are allochthonous in origin or derived from the terrestrial environment. The vast majority of this allochthonous material arrives in the streams in the form of Coarse Particulate Organic Matter or CPOM (> 1 mm or 0.039 inch in size). Smaller amounts of other allochthonous material that is transported to the stream includes Fine Particulate Organic Matter (FPOM, 50 um – 1 um in size or 0.0019 - 0.000039 inches in size) and Dissolved Organic Matter (DOM) traveling from surface and groundwater flow. Microbes and specialized macroinvertebrates living in headwater streams, called shredders, feed on the DOM and CPOM, converting it into FPOM and DOM. The FPOM and DOM are carried downstream to mid-sized streams.

Because mid-sized streams (fourth- through sixth-order) are wider than headwater streams, the canopy is usually more open and more light is able to penetrate to the stream bottom. As a result, a greater abundance of algae and aquatic plants are able to grow along the stream bottom. In general, the contribution of allochthonous material derived from terrestrial vegetation in midsized streams is less than in the headwater streams. Autochthonous material, meaning material that is derived from within the stream, becomes an important component of the energy budget in midsized streams. Autochthonous material includes both the primary productivity of the stream and the FPOM and DOM derived from upstream reaches which flow into midsized stream. Consequently, mid-sized streams may exhibit a shift from a heterotrophic to an autotrophic system, or one that generates its own energy through photosynthesis. The biological community of mid-sized streams differs somewhat from that in headwater streams in part because of the more diverse types of energy sources that are available. Specialized macroinvertebrates called collectors-filterers and collector-gatherers break down the FPOM carried from upstream reaches into Ultra-fine Particulate Organic Matter (UPOM, 0.5 – 50 mm in size or 0.019-1.97 inches in size). These macroinvertebrates, as well as microbes, also consume living plant matter (algae and aquatic plants) converting it into additional forms of energy. The UPOM derived from these energy sources is then carried downstream to larger rivers. Interestingly, collectors can actually also increase particle sizes in some cases by feeding on material in the several micron range and defecating compacted feces of a much larger particle size. These larger particles then become available to larger particle feeding detritivores (Wallace et. al., 1992).

Larger rivers (seventh- through twelfth-order) have different biological communities from lower order streams. The increased width of these rivers results in relatively insignificant allochthonous inputs. The depth, combined with suspended mineral and organic matter, prohibit much light penetration and consequent growth of algae and plants within the main channel. Collectors again become the primary macroinvertebrate community to process the particulate organic material. Larger rivers tend to be heterotrophic systems.

Figure III.C-1 illustrates the flowchart summarizing the energy processing that occurs within the river ecosystem.

Figure III.C-1
Energy Resource Categories and Invertebrate Classifications in River Ecosystems
(from Merritt and Cummins, 1996)



Several major models have been developed to describe the movement of energy and nutrients in rivers. These theories include the River Continuum Concept developed in Vannote et al. (1980) and the concept of nutrient spiraling. The development of the River Continuum Concept greatly improved the scientific communities' understanding of the ecosystem-level functions of rivers and provided direction for lotic ecosystem research over the last 20 years.

River Continuum Concept

The River Continuum Concept (Vannote et al., 1980) is a theory that details how differing energy sources are processed efficiently, progressing from headwater streams to large rivers. This theory explains that energy sources are dependent upon geomorphological, chemical, and biological factors that have evolved within the surface water ecosystem to create a balanced energy transport. The general metabolism for the river ecosystem uses energy that is transported downstream from upstream reaches within the system.

From the headwaters to the mouth of the river, the river ecosystem is comprised of a balanced, efficient, longitudinal gradient of energy sources and processing in which the particle size of organic matter becomes more refined as the river becomes larger (Vannote et al, 1980). In each portion of a river ecosystem, some organic matter is processed, some stored, and some released (Vannote et al., 1980). Organic matter is conditioned by microbes (fungi and bacteria), and some is respired (to carbon dioxide) by microbes and animals, some converted to smaller particles and dissolved organic matter which is exported to downstream communities (Vannote et al. 1980). Macroinvertebrate communities at each section of the river ecosystem have become specifically adapted to maximize the processing of energy available in the form of organic matter. Since macroinvertebrate communities serve as a food base for higher trophic organisms (i.e., fish) in the food web, these higher trophic organisms have also evolved to fit available niches in the stream ecosystem. Figure III.C-2 summarizes the River Continuum Concept and the types of benthic macroinvertebrates mentioned that are typically distributed along the river ecosystem. General range of stream widths (in meters) are given for each order.

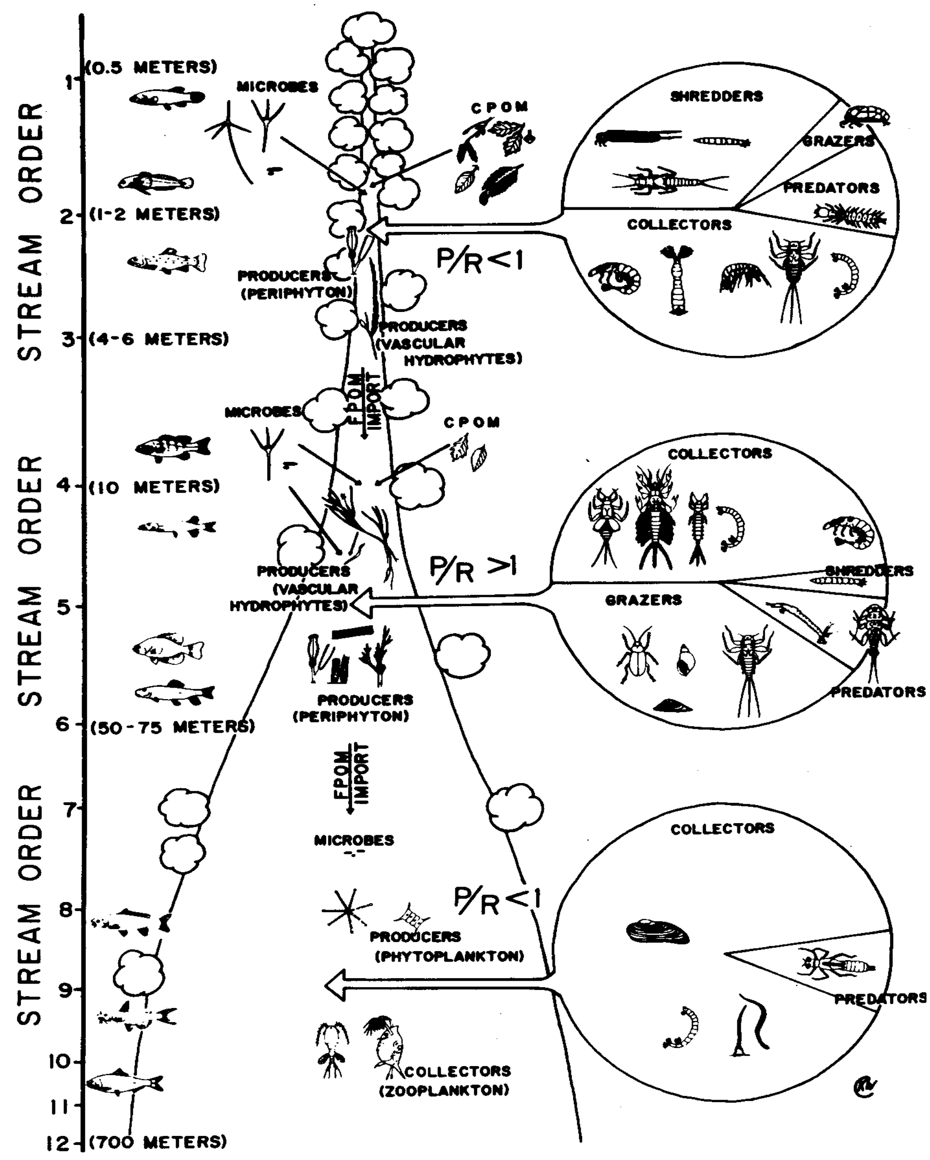
Heterotrophic systems are designated by the P/R ratio (gross photosynthesis to community respiration ratio) < 1, and autotrophic systems are designated by the P/R > 1.

c. Animal Communities

c.1. Invertebrates

Stream order typically dictates the community structure of the resident aquatic life. Headwater streams harbor primarily benthic macroinvertebrate communities who are specialized to feed on the CPOM deposited in the system. Examples of benthic macroinvertebrates include crayfish, worms, snails and flies. The majority of benthic macroinvertebrates in headwater streams are classified as shredders and collectors, who feed on the CPOM and FPOM, and predators who feed on the other macroinvertebrates. Typical benthic macroinvertebrates found in headwater streams in the study area include insects such as mayflies (Ephemeroptera), stoneflies (Plecoptera), caddisflies (Trichoptera), dragonflies and damselflies (Odonata), beetles (Coleoptera), dobsonflies and alderflies (Megaloptera), true bugs (Hemiptera), springtails (Collembola), and true flies (Diptera). Other macroinvertebrates that have been collected include crayfish (Decapoda), isopods (Isopoda), worms (Oligochaeta and Annelida) and snails (Gastropoda) (FWS, 1998; Science Applications International Corporation, 1998).

Figure III.C-2
Diagrammatic Representation of the River Continuum Shown as a Single Stream of Increasing Order
(Vannote et al., 1980)



In the southern Appalachian Mountains, macroinvertebrates of several orders including Ephemeroptera, Plecopter and Trichoptera have been found to be rich in species, including many endemic species and species considered to be rare. This diversity and unique assemblage of species has been attributed to the unique geological, climatological and hydrological features of this region (Morse et al., 1993, Morse et al., 1997). Many biologists agree that the presence of a biotic community with such unique and rare populations should be considered a critical resource.

Stream macroinvertebrates are typically classified on the basis of their functional feeding group (Cummins 1973, Cummins and Klug 1979, Merritt and Cummins 1984). Insects within a functional feeding group share similarities in their morphology, feeding behavior and feeding mechanisms (e.g., scraping, collecting, shredding, filtering, etc.). Typical functional feeding groups are described below.

Scrapers

Scrapers are adapted to scape materials such as, algae or periphyton and its associated microflora from rock or organic substrates, such as leaves (Wallace et al., 1992). Typically scrapers include certain taxa of snails, mayflies, caddisflies, beetles and fly larvae.

Shredders

Shredders chew primarily large pieces of decomposing vascular plants ($\geq$ 1 mm or 0.039 inch diameter) along with its associated microflora and fauna. They may also feed directly on living vascular hydrophytes or gouge decomposing wood submerged in streams (Wallace et al., 1992). In addition to aquatic insects, many omnivorous crayfish in the study area are facultative shredders. Shredders are important because their mode of feeding causes the generation of large quantities of small particles. These particles are more easily transported downstream and may be acted on by microbes more easily due to the increase in the surface area to volume ratio. Common shredders in the study area are certain taxa of stoneflies, caddisflies and fly larvae.

Collector-gatherers

Collector-gatherers feed primarily on fine pieces of decomposing particulate organic matter (FPOM $\leq$1 mm or 0.039 inch diameter) deposited within streams (Wallace et al., 1992). Many chironomidae larvae are collector-gatherers.

Collector-filterers

Collector-filterers have specialized anatomical structures (setae, mouthbrushes, fans, etc.) or silk and silk-like secretions that act as sieves to remove particulate matter from suspension (Jorgensen 1966, Wallace and Merritt, 1980) (Wallace, 1992). Some mayflies, caddisflies and fly larvae are collector-filterers.

Predators

Predators feed on animal tissues by either engulfing their prey or by piercing prey and sucking body contents (Wallace et al., 1992). Predators include dragonflies, hellgrammites, some taxa of stoneflies, caddisflies, beetles, fly larvae and some crayfish.

c.2. Vertebrates

Two groups of vertebrates, fish and salamanders are the major stream-dwelling vertebrates in the study area. Typically, salamanders occupy small, high-gradient headwater streams while fish occur farther downstream. Predation by fish is believed to restrict salamanders to the smaller streams or the banks of large streams (Wallace et al., 1992).

Fish species present in headwater streams tend to be representative of cold water species, and primarily sustained by a diet of invertebrates (Vannote et al, 1980). As found with invertebrates and amphibians, the fish assemblages of the Appalachians tend to contain a relatively large number of endemic and unique species. Some fish species collected in the pristine headwaters of West Virginia include blacknose dace (*Rhinichthys atratulus*), creek chub (*Semotilus atromaculatus*), and slimy sculpin (*Cottus cognatus*) (FWS, 1998).

Many different kinds of amphibians and reptiles live in or near streams and wetlands. Many types of amphibians in particular are unique to the Appalachian regions. The West Virginia Division of Natural Resources has published a pamphlet, "Amphibians and Reptiles of West Virginia: A Field Checklist." This list mentions 46 amphibious species and 41 reptilian species, the vast majority of which are most likely located throughout the study area within suitable habitat of Kentucky, Tennessee, and Virginia. These species include mole, dusky, woodland, four-toed, green, spring, red, mud, and brook salamanders as well as newts, hellbenders, and mudpuppies, which can frequently be found near aquatic habitat. Skinks, a lizard species, can also be found around aquatic habitats. Toads as well as cricket, chorus, true, leopard, pickerel, and treefrogs are associated with aquatic habitats. Snapping, spotted, map, musk, mud, and painted turtles as well as sliders, cooters, redbellies, and softshells can also be found in these areas. Water, crayfish, brown, garter, ribbon, and kingsnakes are associated with aquatic habitats. Many of these amphibious and reptilian species may be primarily terrestrial, but live in proximity to aquatic areas such as streams and wetlands. In addition, several species strictly rely on the presence of streams or wetlands for at least part of their life cycle (Conant and Collins, 1991).

The diversity and distribution of fishes in West Virginia is intimately related to drainage divides. The Potomac and James rivers drain the Atlantic Slope, while the remainder of the state drains to the Gulf of Mexico via the Ohio and Mississippi rivers. The fauna of all West Virginia systems draining into the greater Ohio River are similar in composition and have an interrelated history. The greater Ohio River drainage is chiefly comprised of the Monongehela, Little Kanawha, Kanawha, Guyandotte, and Big Sandy/Tug Fork rivers. The upper Kanawha (New) River system above the Kanawha Falls has a unique fauna with six endemic species; the bigmouth chub (*Nocomis platyrhynchus*), the New River shiner (*Notropis scabriceps*), the Kanawha minnow (*Phenacobius teretulus*), the candy darter (*Etheostoma osburni*), the Kanawha darter (*Etheostoma kanawhae*), and the Appalachia darter (*Percina gymnocephala*); all but *E. kanawhae* occur in West Virginia. For this reason, the New River is treated separately from the greater Ohio River drainage with respect to fish distribution. In the ichthyological literature, New River refers to all of the Kanawha River drainage above Kanawha Falls (Stauffer and Ferreri, 2002).

A shift in the fish community from cold-water to more warm-water fish species occurs in mid-sized streams. Generally, the fish community becomes more diverse and more piscivores (fish-eaters) coincide with the invertivores (Vannote et al, 1980). Studies have determined that approximately 277 native freshwater fish species, distributed among 22 families exist within the central Appalachian drainages (EPA, 1983). Minnows, suckers, catfishes, sunfishes, and perches are the five predominant families. (EPA, 1983). The lack of modifications, combined with numerous geological, climatic, and hydrological events in eastern Kentucky have allowed the rivers to harbor a fairly diverse fish community (EPA, 1983). In addition, the geological events associated with the development of the river system within the MTM/VF EIS study area have resulted in a unique fishery system which has importance in the evolution and speciation of North American freshwater fishes (Stauffer and Ferreri, 2002).

d. Ecosystem Function

The value of headwater streams in the study area was the subject of a symposium held in April 1999. The proceedings of this symposium have been included in Appendix D and are summarized below.

The changes in invertebrate communities from stream headwaters to mouth have been well documented. However, local conditions may exert as great or greater an influence on the biotic communities as can be seen by examining stream order alone. In general, major shifts in the relative abundance of macroinvetebrates considered to be shredders, scrapers and collector-gatherers are seen from headwaters to mouth. Collector-filterers and predators are generally found in all stream orders. However, differing species may occur to occupy these niches in different stream reaches. Shredders are generally relatively abundant in headwater areas where allochthonous inputs are high, and present in lower abundance in mid-order streams, where less of the organic matter input is allochthonous. Shredders may be absent or occur in only localized conditions in higher order streams. Scrapers tend to be present at a relatively low abundance in headwater streams owing to the relatively low amount of periphyton (periphyton inhabiting the surfaces of underwater vegetation, rocks, and other substrates) present in these stretches. The relative abundance of scrapers increases in mid-order streams in conjunction with an increase in periphyton abundance, but decreases again in high order streams owing to decreases in suitable habitat and physical limitations. Collector-filters are present in all reaches of a stream. However, the species occupying these niches varies tremendously, from almost entirely arthropods in headwater streams to largely molluscs and arthropods, especially aquatic insects, in high-order rivers.

Small streams play a pivotal role in lotic ecosystems. Small streams:

- Have maximum interface with the terrestrial environment with large inputs of organic matter from the surrounding landscape
- Serve as storage and retention sites for nutrients, organic matter and sediments
- Are sites for transformation of nutrients and organic matter to fine particulate and dissolved organic matter
- Are the main conduit for export of water, nutrients, and organic matter to downstream areas (Wallace in Symposium on Aquatic Ecosystem Enhancement at Mountain Top Mining Sites, January 2000)

The major functions of headwater streams can be summarized into two categories, physical and biological (Wallace in Symposium on Aquatic Ecosystem Enhancement at Mountain Top Mining Sites, January 2000):

Physical

- Headwater streams tend to moderate the hydrograph, or flow rate, downstream
- They serve as a major area of nutrient transformation and retention

- They provide a moderate thermal regime compared to downstream waters- cooler in summer and warmer in winter
- They provide for physical retention of organic material as observed by the short "spiraling length"

Biological

- Biota in headwater streams influence the storage, transportation and export of organic matter
- Biota convert organic matter to fine particulate and dissolved organic matter
- They enhance downstream transport of organic matter
- They promote less accumulation of large and woody organic matter in headwater streams
- They enhance sediment transport downstream by breaking down the leaf material
- They also enhance nutrient uptake and transformation

In summary, light and the input of allochthonous material are the two limiting factors in the contribution of energy to a river ecosystem as a whole. When an energy source is altered or removed in the upstream reaches, downstream biological communities are also affected. The value of headwater streams to the river ecosystem is emphasized by Doppelt et al. (1993): "Even where inaccessible to fish, these small streams provide high levels of water quality and quantity, sediment control, nutrients and wood debris for downstream reaches of the watershed. Intermittent and ephemeral headwater streams are, therefore, often largely responsible for maintaining the quality of downstream riverine processes and habitat for considerable distances."

2. Lentic (Non-flowing) Aquatic Systems and Wetlands

a. Overview

Lentic aquatic systems are defined as non-flowing water bodies such as lakes and ponds. Strausbaugh and Core (1978) states that there are no natural lakes and ponds in West Virginia (other than beaver ponds). This statement highlights several features of the lentic systems found in the study area. Virtually all lentic systems in the study area have been formed by impounding flowing water systems. The majority of the lentic systems in the study area are small ponds. Small impoundments are constructed for agricultural use, community water supplies, recreational areas, or flood control, or may have resulted from road construction or surface mining activities (Menzel and Cooper, 1992).

There is no clear distinction between a pond and a lake. Attempts have been made to classify lentic water bodies as ponds or lakes depending on depth and on surface area. A reasonable distinction between ponds and lakes may be made on the type of lake mixing that occurs. Water bodies may be considered lakes when the wind plays the dominant role in mixing. In ponds, gentler convective mixing predominates (Goldman and Horne, 1983).

ON A REGIONAL SCALE, SMALL PONDS OR IMPOUNDMENTS IN THE APPALACHIANS PROVIDE HABITAT FOR COMMON ANIMAL AND PLANT POPULATIONS THAT REQUIRE AQUATIC CONDITIONS FOR FEEDING OR REPRODUCTION.

Wetlands are also a water-related system that occurs throughout the study area. As per section 404 of the Clean Water Act, wetlands are defined as:

> Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

As can be seen from this definition wetlands and lentic aquatic systems may be overlapping. Note that this regulatory definition does not define shallow lakes and ponds as wetlands. For resource mapping purposes, the FWS (Cowardin et al. 1979) has also defined wetlands as follows:

> Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification, wetlands must have one or more of the following three attributes: 1. At least periodically, the land supports predominantly hydrophytes; 2. The substrate is predominantly undrained hydric soils; and 3. The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

In this definition, shallow lakes and ponds are included as wetlands. Wetlands are frequently mapped using the classification system developed by Cowardin et al. (1979). In this system, some types of lentic systems (i.e. lakes) are designated as deepwater habitats as distinct from wetlands, while ponds are typically considered to be a type of palustrine wetland.

b. Physical Environment

Four elements play a major role in defining the structure of a lake or pond. These include the physical characteristics, chemical characteristics, biological characteristics and the watershed for a particular pond or lake.

The hydrology of the lentic systems in the study area is dependent, in many cases, on both surface runoff, as most ponds are formed by damming a small stream, and by groundwater input. Springs and other gains from groundwater may provide the majority of the water to some ponds (Menzel and Cooper, 1992). Studies have found that water levels in Appalachian impoundments tend to remain fairly constant over the year. However, sediment inflows may greatly reduce the capacity of impoundments, especially in the years immediately following impoundment construction.

Watershed conditions can greatly affect conditions in Appalachian impoundments. For example, ponds located in a forested setting would tend to receive more allochthonous input than ponds located in agricultural settings. Depending on the variation in inputs to ponds, i.e., terrestrial detritus versus algae in more open reaches, the change in energy base can also influence the food base and the community structure of ponds.

Small impoundments in this region are usually classified as soft water with dissolved solids less than 120 mg/L and hardness less than 60 mg/L as Ca CO3 (Geraghty et al., 1973). Even in limestone regions dissolved solids rarely exceed 350 mg/L with a maximum hardness of 120 mg/L (Menzel and Cooper, 1992). Impoundment pH typically ranges from 4.1 to 10. Most Appalachian impoundments are found to be phosphorus limited, as is true for most freshwater bodies (Menzel and Cooper, 1992).

c. Energy Sources and Plant Communities

Plant communities in ponds and lakes consist of submerged, floating and emergent vascular plants, phytoplankton, and periphyton. Autotrophic bacteria may also occur in lentic systems and contribute to the primary production of these systems.

c.1. Phytoplankton and Benthic Dwelling Micro-organisms

Phytoplankton

All major groups of algae are found in small ponds. However, the species distribution of small ponds generally differs from that of large impoundments and lakes. In small ponds, benthic algae and periphyton may detach and become part of the planktonic community (Menzel and Cooper, 1992).

If nutrient enrichment is present, blue-green algae (i.e., cyanobacteria) in small ponds may become dominant. This results in negative impacts from several perspectives. Blue-green algae is often considered noxious to humans and are often rarely consumed by planktivores.

Bacteria and Fungi

Bacteria and fungi are the major decomposers in small ponds. Although these organisms may occur as part of the planktonic community, the vast majority of bacteria and fungi are found on or in the top several centimeters of sediments. Bacteria and fungi may also represent a food source for benthic dwelling organisms.

c.2. Vascular Plants

Vascular plants in small impoundments include species with submergent, float-leaved or emergent growth forms. Submergent macrophytes are found rooted in benthic sediments at depths from 3 to 12.5 feet depending on light penetration. Submergents may occur in patches or may cover the entire bottom of ponds.

Floating or floating-leaved vascular plants may be very abundant in small ponds if nutrients are present. Where these plants are found in abundance, they may reduce the photosynthesis in the hypolimnion, (cold lower layers of a body of water) resulting in an increase in water column respiration. This may result in anoxic (low amounts of oxygen in the water) conditions in the water column, with elimination of fish in the pond (Menzel and Cooper, 1992).

Emergent macrophytes typically occur where sedimentation or benthic morphology has resulted in sediments located at a suitably shallow depth from the surface of the water. Examples of emergent species common to ponds in the Appalachian Mountains include cattails (*Typha latifolia*) and willows (*Salix sp.*). Emergent macrophytes are an important energy source for small impoundments and provide habitat for numerous vertebrate wildlife (Menzel and Cooper, 1992).

Small ponds tend to fill with sediments as they age. This results in changes in the plant community beginning with sparse populations of non-persistent emergents and submergents in the first several years after impoundment. Pond vegetation 8 to 25 years after impoundment may be characterized as latter successional wetland plant communities consisting of woody vegetation on the pond margin, emergent persistent vegetation located inside the woody margin, and a pond surface and substrate largely covered by submergent or floating-leaved species or absent entirely (Gunn, 1974).

c.3. Primary Production

Most ponds found in the southern Appalachians tend to be highly productive, eutrophic systems, (having concentrations of nutrients optimal or nearly so for plant or animal growth), although some small impoundments in this area may be oligotrophic (low concentrations of plant nutrients and hence low productivity). Submergent or emergent vegetation is the primary source of primary production in these systems (Menzel and Cooper, 1992). The presence of nutrients, light penetration, and temperature appear to be the major factors influencing primary production in small impoundments in the study area.

d. Animal Communities

Animal communities may be arbitrarily divided into two groups: those dwelling in the benthos and those dwelling in the water column. Often organisms move between these two zones during their lifecycle (Menzel and Cooper, 1992). Invertebrate groups found in small impoundments include zooplankton and insect larvae. Major vertebrate groups include fish and reptile. Birds may heavily utilize vegetated portions of the benthos for feeding and breeding.

d.1. Invertebrates

Pond invertebrates may function as primary consumers or secondary consumers and also represent a major food source for fish.

Zooplankton

Major groups of zooplankton include the Cladocera, Copepoda and Rotifera. Zooplankton populations exhibit seasonal population cycles, which may be controlled by a variety of factors. Zooplankton may feed on phytoplankton, detritus or other zooplankton. They are considered to be important in the nutrient cycling dynamics of small ponds.

Zoobenthos

Major groups of benthic dwelling organisms in ponds include aquatic oligochaetes (worms), crustaceans and immature insects. Feeding modes for zoobenthos include herbivorous, carnivorous and detrital feeding. Organisms feeding on detritus may actually obtain a majority of their energy from the microbial fraction of the detritus (Walker, Olds and Merritt, 1988). Zoobenthos greatly increase the secondary productivity in ponds through exhibiting high growth rates (Cooper, 1987). For example, some Chironomidae (Midge flies) may experience up to 10 life cycles per year in southern Appalachian ponds (Cooper, 1987).

d.2. Vertebrates

Five major groups of vertebrates are found in small impoundments in the southern Appalachians including fish, amphibians, reptiles, birds and mammals. These animals inhabit or use freshwater ponds for feeding or breeding during at least some part of their lifecycle. Available literature indicates a limited species diversity in all groups except birds (Menzel and Cooper, 1992).

Fish are generally the dominant predators in ponds. Predominant types of fish in small impoundments include bluegill and other sunfish, brown bullhead, bass, yellow perch and golden shiner. Frogs, turtles, and water snakes are other commonly occurring vertebrate species found in small impoundments.

e. Ecosystem Function

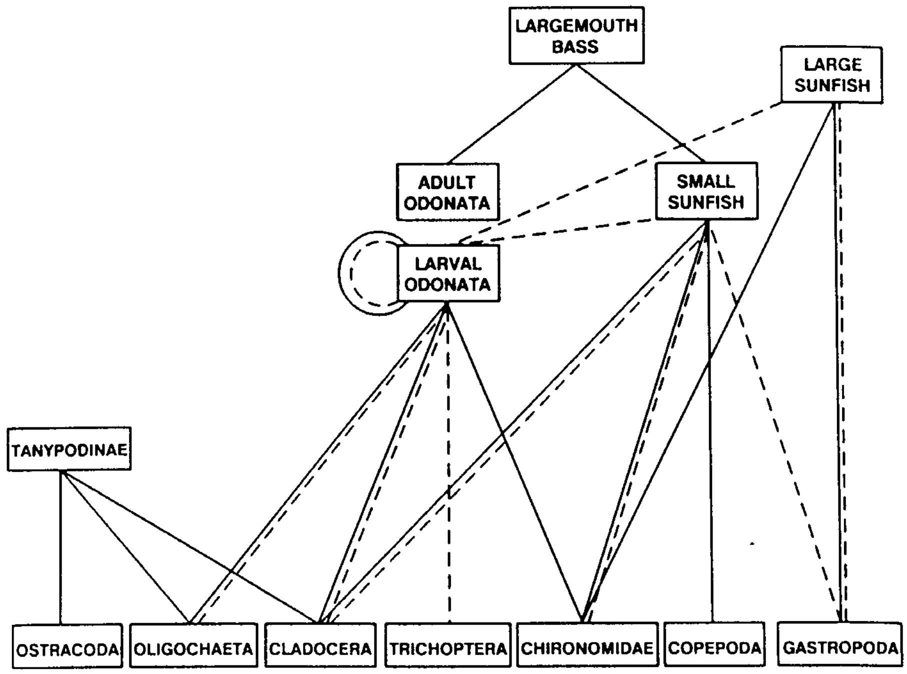
Small ponds or impoundments serve a variety of functions within the regional ecosystem, but also exhibit distinct internal ecosystem dynamics. On a regional scale, small ponds or impoundments in the Appalachians provide habitat for common animal and plant populations that require aquatic conditions for feeding or reproduction. These may include animal species such as beaver, waterfowl, fish or pond-dwelling obligate aquatic plant species. Small impoundments may contribute to flood control, and may improve the water quality of riparian systems downstream from the impoundment through the temporary removal of organic and inorganic nutrients and toxic materials from water that pass through them (Mitsch and Gosselink, 1993).

Ecosystem-level functions occurring within small ponds and impoundments include food web and the related energy flow relationships. Food webs in pond systems are well-developed and have been well studied (Johnson and Crowley, 1989). A typical food web of a small pond or impoundment system is summarized in Figure III.D-1, Major links in the food web of littoral zones. Compared to small streams, ponds are relatively self contained and have a limited ability to cycle nutrients on a watershed scale.

This figure summarizes a study of the feeding web occurring in the littoral zone of Bays Mountain Lake, which is located in Sullivan County, Tennessee. The watershed of this lake was classified as forested mountaintop (Crowley and Johnson, 1982). This lake is anticipated to be similar to natural ponds found in the study area. As shown in this figure, insect larvae, crustaceans, oligochaetes, gastropdods (snails), and ostracodas (minute fresh-water crustaceans with a bivalve, hinged shell) accounted for the majority of the secondary productivity in the shallow area of this pond. These organisms were consumed by predacious midge larvae (Tanypodinae), larval dragonflies and damselflies (Odonata), and small sunfish.

Large sunfish also consumed some benthic immature insects and gastropods, but were found to feed on larval odonates (dragonflies and damselflies) as well. The top predators within the pond were largemouth bass. These fish fed primarily on small sunfish and adult odonata. Food webs of other ponds and small impoundments in the study area have been found to exhibit similar types of food webs as illustrated in the figure. As summarized by Menzel and Cooper (1992), "Thus, while specific producers and consumers of importance may be dictated by habitat, abiotic parameters, or geographic location, the generalized pond food web is predictable."

Figure III.C-3
Major Links in the Food Web of Littoral Zones — Prey Comprising at Least 10% of the Diet of Predators — Statistically Significant Depletion of Prey Populations in Enclosure Experiments
(from Johnson and Crowley, 1989)



f. Wetlands in Study Area

The wetlands and deepwater habitats in the MTM study area are almost entirely riverine (rivers and streams) or palustrine (e.g., marshes, swamps and small shallow ponds) (Tiner 1996). In West Virginia, palustrine wetlands, primarily ponds, have been found to be the most abundant type of wetland (Tiner 1996). Nearly all (99%) of the state's wetlands fall within the palustrine system. West Virginia's wetlands are mostly comprised of ponds, forested wetlands, and emergent wetlands (Tiner 1996). Reviewing wetland inventory summary maps available on the web (www.dep.state.wv.us/watershed), it can be seen that palustrine wetlands are common in areas of the state with extensive riverine wetlands. However, many isolated palustrine wetlands occur in areas lacking riverine systems as well.

A qualitative assessment of the occurrence of wetlands in areas subjected to surface mining compared to areas which had not experienced surface mining was performed as part of this EIS. National Wetland Inventory (NWI) maps produced by the FWS for the States of Virginia and West Virginia and the Commonwealth of Kentucky were used in this evaluation. One observation from this evaluation is that areas with surface mining frequently contain numerous, small ponds (indicated as wetlands classified as PUB or PUS, palustrine unconsolidated bottom or palustrine unconsolidated shore, respectively). Areas lacking surface mining did not appear to have as many small ponds as did mined areas. It is likely that these ponds were created as a result of surface mining activity. Additionally, in the review of the NWI maps for this area, it is clear that these numerous, small pond-type wetlands on surface mining sites are not directly connected to the stream system in the region. Most of these wetlands appear to be formed in isolated small depressions on the formerly surface mined area. As such, these isolated pond-type wetlands would not be expected to contribute to energy flow or nutrient cycling in the stream system of the watershed. Ongoing research is being conducted on techniques for developing pond-type wetlands that would be more integrated with watershed-level aquatic functions (see Atkinson et al. 1997). However, most of this work is still in the conceptual stages. Programs such as the Powell River Project (http://als.cses.vt.edu/prp/index.html) are pursuing research to improve techniques for wetland construction/restoration on surface mining sites.

Existing information on surface mining techniques indicates that some surface mining practices do tend to result in pond formation both before and after mine restoration while other practices do not result in the formation of ponds (Atkinson and Cairns 1994, Atkinson et al. 1996). It is also important to note that the NWI maps generated for West Virginia were developed based on aerial photography from the early 1980's. In the past 15 to 20 years, it is likely that many of the wetland/ponds mapped as PUB may now contain emergent vegetation such as cattails.

Other types of palustrine wetlands such as forested swamps or shrub swamps were also observed in the study areas associated with creeks or rivers as marked in the NWI maps. It is believed that these areas are largely naturally formed wetlands and are not related to mining practices based on their position in the landscape and the maturity level of the vegetation in these wetlands (Tiner 1996).

The ecosystem functions of created lentic systems were discussed and summarized during a symposium on aquatic ecosystem enhancement held in January, 2000 by the MTM/VF EIS work group investigating this technical study area (EPA et al. March 20, 2000). Several presenters from academia, coal companies and environmental consultants discussed the values of man-made pond and wetland systems.

Characteristics and functions of man-made ponds and wetlands, as summarized by Dr. Wallace in EPA (March 20, 2000) include:

- Less of an interface with terrestrial environments than seen with headwaters streams
- Autochthonous primary productivity, primarily from algae and aquatic plants
- Energy systems tend to be closed with less linkage, if any, to other areas, or downstream ecosystems
- Disturbance in a pond will tend not to affect other ecosystems such as downstream areas
- These systems can be important sites of nutrient storage and uptake provided that a sufficiently vegetated littoral zone is present
- Under post-mining conditions, biological communities appear to resemble natural communities and are not as indicative of disturbance as is found in headwater streams

REI Consultants evaluated aquatic habitat functions provided by sediment control ponds and ditches (in EPA March 20, 2000). They found that functions present depended on the age of the structure with the number of functions increasing with structure age. The establishment of functions also depended somewhat on water quality though older ponds tended to exhibit better water quality in most cases. Functions provided by the ponds and ditches included:

- Habitat for groups of aquatic insects typical to lentic habitats
- Water filtration/nutrient fixation
- Wildlife habitat including fish habitat for fish typical of small ponds
- Possibly, water treatment through filtration and precipitation. This function may be of increased importance for ponds developed in channels leading to headwater streams

In summary, functions of man made ponds and wetlands exist and may be considerable. While these functions differ from those of headwater streams, these functions do have their own inherent values. In fact, the establishment of ponds or wetlands on benches or at the toe of mined areas may tend to limit the effect of disturbances on the downstream watersheds (Wallace, B. in EPA et al. March 20, 2000).

3. Interrelationship Between Headwater Streams and Native Forests

Riparian (water-edge) habitats are transitions (ecotones) between terrestrial and aquatic environments and constitute a transition zone through which energy, nutrients, and species are exchanged. These areas typically are especially productive biological communities in which both species diversity and species densities are high (Warner, 1979). Characteristic woody vegetation exists in narrow bands along the streams that dissect this rugged landscape and include such species as black willow (*Salix nigra*), silver maple (*A. saccharinum*), box-elder (*A. negundo*), hackberry (*Celtis occidentalis*), sycamore (*Platanus occidentalis*), and cottonwood (*Populus deltoides*). In the rich alluvial soils along the streams, many species of shrubs and herbaceous plants can be found. Riparian habitat in the study area is limited to the narrow bands along the numerous streams because of the mountain and valley topography (WVDNR Water Resources 1976a).

THE SOUTHERN APPALACHIANS HAVE THE RICHEST SALAMANDER FAUNA IN THE WORLD

The headwater streams of the study area have a profound influence on the surrounding terrestrial habitat-- just as the terrestrial habitat influences the headwater streams. Leaves tend to blow across the forest floor and collect in the headwater streams which are wet depressions in the landscape. Very little of this coarse organic material in the form of leaves is transported downstream; most is processed by living organisms. The importance of the relationship between streams and the native forests is highlighted by the difference in coarse organic material inputs between streams flowing through forests and streams flowing through grassy areas. Streams flowing through grassy areas have much lower inputs of coarse organic material than streams flowing through forests (Sweeny, USFWS 2000). Also, different kinds of leaves from different species of trees affect the production and biomass of invertebrates. In addition, as precipitation percolates through leaves on the forest floor, it extracts organic compounds from the leaves. These dissolved organic compounds drive a major portion of the aquatic system's productivity (USFWS 2000). In aquatic ecosystems, the degree of land-water interaction between the terrestrial environment and the aquatic environment influences ecological processes and food web interactions (Adams and Hackney, 1992). The headwater streams of the study area have maximum terrestrial-aquatic interface ratios. Thus, the interconnection of the terrestrial and aquatic environments is greatest in these headwater streams. As mentioned previously, allochthonous organic matter typically dominates in headwater streams and other aquatic ecosystems with high ratios of land-water interaction. Therefore, the importance of surrounding forests to these streams can be easily understood in terms of generating energy for the aquatic ecosystem in the form of dead leaves and other organic matter. In addition to this relationship are the interrelationships between terrestrial wildlife and the aquatic environment of headwater streams in the study area.

The southern Appalachians have one of the richest salamander fauna in the world (Petranka 1998, Stein et al., 2000). Many species of salamanders are aquatic or semi-aquatic and utilize headwater streams at some point in their life histories. These aquatic and aquatic-phase (some larvae) salamanders are entirely predaceous and generally include a large proportion of aquatic insects in their diets (Wallace et al., 1992). The dusky salamander (*Desmognathus fuscus*), a semi-aquatic species, is a stream-side inhabitant of mountain brooks and seeps in the Appalachians. The dusky salamander spends the majority of its time in the terrestrial-aquatic environment interface zone, along the margin of streams and seeps, opportunistically foraging on insects, slugs, and other invertebrates (Burton, 1976). Salamanders constitute a large portion of the animal biomass in eastern forests, in particular, in headwater streams. Biomass of the genus *Desmognathus* alone ranges from 1.673 to 2.683 g/m^2 (0.484 oz/yd^2 to 0.078 oz/yd^2) from four studies of headwater streams in the Southeastern United States (Wallace et al., 1992).

Many purely terrestrial species also depend on the headwater streams in the study area for their survival and the terrestrial-aquatic ecotone results in a diverse flora and fauna for these locations. For example, unique avifauna assemblages can be found along the riparian zone of headwater streams. The acadian flycatcher (*Empidonax virescens*) is commonly encountered throughout the study area (Buckelew and Hall, 1994), but is seldom found in upland forests, favoring the understory vegetation along small headwater streams where it feeds on emergent aquatic insects (Murray and Stauffer 1995). Neotropical migrant songbirds are also often attracted to headwater stream areas for breeding areas because of the diversity of the habitat and the availability of emergent aquatic insects. The Louisiana waterthrush (*Seirus motacilla*) neotropical migrant song bird is considered an <u>obligate</u> headwater riparian songbird because its diet is comprised predominantly of immature and adult aquatic macroinvertebrates found in and alongside these streams and it builds its nest in the stream banks (Mulvihill 1999). The Louisiana waterthrush is one of the earliest arriving migrants to the study area that places its nest among vegetation along flowing streams . The Louisiana waterthrush is also an area-sensitive species, requiring undisturbed forest tracts of 865 acres to sustain a population (Buckelew and Hall 1994). Therefore, preservation of large tracts of forest containing headwater streams is needed for the conservation of the Louisiana waterthrush in the central Appalachians (Murray and Stauffer 1995).

D. IMPACT PRODUCING FACTORS TO HEADWATER STREAMS FROM MOUNTAINTOP MINING

1. Studies Relating to Direct and Indirect Surface Water Impacts from Mountaintop Mining and Valley Fills

Surface mining operations in steep slope terrain generate excess spoil that is often placed in adjacent valleys. Mining operations and associated fills can directly impact headwaters by mining through or burying streams and eliminating existing terrestrial, riparian, and aquatic habitats. These operations also have the potential to indirectly impact stream conditions downstream from fills through physical or chemical changes. . In scoping discussions held to evaluate the impacts of MTM/VFs on headwater streams, eight potential impact factors were identified and are listed below.

Potential Impact Factors

1. Loss of linear stream length
2. Loss of biota under fill foot print or from mined stream areas
3. Loss of upstream energy from buried stream reaches
4. Changes in downstream thermal regime
5. Changes in downstream flow regime
6. Changes in downstream chemistry
7. Changes in downstream sedimentation (bed characteristics)
8. Effects to Downstream Biota

These factors fall into two categories: those occurring from the direct filling or mining of headwater streams (Factors 1, 2 and 3 in part), and those factors that manifest their effects through changes in characteristics of the stream located downstream from filled or mined areas (Factor 3 in part and Factors 4 through 8). These factors are related to the functions performed by headwater streams within the ecosystem. This section will focus on studies relating to each of these potential impact factors.

a. Loss of Linear Stream Length from Filling and Mining Activities Associated with Fills

Three studies examined the loss of stream length from valley filling. The findings of these studies are summarized below.

The EIS steering committee commissioned a study to determine the extent of valley fills in the EIS study area. This study, known as the fill inventory, includes a variety of information regarding valley fills constructed from 1985 to 2001, including the feet of stream under valley fill footprints. This study measured streams based on a synthetic stream network defined on a 30-acre watershed accumulation threshold over the National Elevation Dataset (NED). The NED for each state was processed to enforce hydrologic integrity. A flow accumulation grid was prepared and queried to define a drainage network over the entire region. The synthetic stream network represents all drainage for watersheds greater than 30 acres. The fill inventory study (USDOI OSM 2002) is presented in detail in Section III.K. This study estimated that between 1985 and 2001 approximately 724 miles (1.23%) of stream in the EIS study area were directly impacted by valley fills (i.e., covered by fill).

A study performed by the USFWS (USFWS 1998) evaluated stream miles permitted for filled with excess spoil and other coal mining wastes in Kentucky, Pennsylvania, Virginian and West Virginia between 1986 to 1998. This study found that at least 900 stream miles were permitted for filling in this time period. The study did not evaluate actual stream miles filled which are believed to be less than the number of miles permitted to be filled. The geographic area evaluated in this study was larger than that of the EIS study area. However, since 91% of the stream miles approved for fills were located in West Virginia or Kentucky, the results are applicable to this EIS. Other uncertainties relating to the accuracy of this estimate are presented in study. Only blueline streams from USGS topographic maps were included in this evaluation. This study did not evaluate miles of stream filled that were not marked as blueline streams, nor was an estimate made for the number of miles of streams mined through.

A cumulative impact study of the length of stream directly impacted within the study area was performed by the USEPA (2002). The stream lengths evaluated were based on the same synthetic stream network as the OSM fill inventory which includes streams located upslope from the USGS blueline streams. This cumulative impact study differed from the previously discussed studies in that the estimate of stream length impacted was based on length of stream filled and length of stream mined through. This study estimated 1,208 miles of direct impact to stream systems in the study area based on permits issued in the last ten years (1992-2002). This estimated of filled or mined through streams represents 2.05% of the stream miles in the study area.

It has been suggested that streams have been, or could be, created during the reclamation of mined or filled sites. It was not the intent nor design of these studies to assess any re-creation of streams. Due to the current lack of data to support creation of viable streams on mining operations, studies exploring the amount of, or possibility for, creation of streams should be considered.

b. Loss of Biota under Fill Foot Print or from Mined Stream Areas

When streams are filled or mined all biota living in the footprint of the fill or in the mined area are lost. There is little question that perennial streams support viable aquatic communities that could be lost from valley fills. However, prior to investigations performed in support of this EIS, the existence of aquatic communities in streams classified as “ephemeral” or “intermittent” was questioned. In fact, the points on the slope of a watershed at which ephemeral, intermittent and perennial streams originated were very poorly understood. Numerous studies in and around the MTM/VF study area had documented the existence of aquatic communities in “headwater stream” systems (See USFWS 1999) but not at the level of geographic detail needed to address questions on the existence of aquatic communities in the upper most stream reaches in the study area.

b.1. Primary Literature Review of Aquatic Communities in Streams with Ephemeral or Intermittent Flow Regimes

Literature results indicated that aquatic organisms could potentially exist in streams with ephemeral and intermittent flow regimes. In western Oregon taxa richness of invertebrates (>125 species) in temporary forest streams exceeded that in a permanent headwater stream (100 species) (Dietrich and Anderson 2000). Dietrich and Anderson (2000) also found that only 8% of the species in the total collection were only found in the permanent headwater. A total of 25% were restricted to the summer-dry streams and 67% were in both permanent and summer-dry streams. In other words, most of the aquatic life found in the temporary streams was also found in permanent streams, clearly indicating that the temporary streams support aquatic life similar to that found in permanent streams. These researchers concluded that the potential of summer-dry streams with respect to habitat function is still widely underestimated.

In several northern Alabama streams of varying flow permanence, including a stream that was normally perennial, Feminella (1996) found little differences in the invertebrate assemblages. Presence-absence data revealed that 75% of the species (171 total taxa, predominantly aquatic insects), were ubiquitous across the 6 streams or displayed no pattern with respect to permanence. Only 7% of the species were found exclusively in the normally intermittent streams. Again, this study clearly indicates that intermittent streams support aquatic life.

Many researchers have found that intermittent streams, spring-brooks and seepage areas contain not only diverse invertebrate assemblages, but some unique aquatic species. Dieterich and Anderson (2000) found 202 aquatic and semi-aquatic invertebrate species, including at least 13 previously undescribed taxa. Morse et al (1997) have reported that many rare invertebrate species in the southeast are known from only one of a few locations with pea-sized gravel or in springbrooks and seepage areas. Kirchner (F. Kirchner pers. comm. 2000 and Kirchner and Kondratieff 2000) reports 60 species of stoneflies from eastern North America are found only in first and second order streams, including seeps and springs. Approximately 50% of these species have been described as new to science in the last 25-30 years.

Williams (1996) reported that virtually all of the aquatic insect orders contain at least some species capable of living in temporary waters and that a wide variety of adaptations across a broad phylogenetic background have resulted in over two-thirds of these orders being well represented in temporary waters. This researcher goes on to say that "perhaps the concept of temporary waters constraining their faunas is based more on human perception than on fact".

b.2. Studies in the MTM/VF Study Area

The USGS (2002 Draft) is completing their "E-point, P-point" study to characterize the size of watersheds located upstream from the starting point of perennial, intermittent and ephemeral headwater streams within the MTM/VF study area. The following table summarizes their results.

Boundary	Median Drainage Area Upstream of Boundary (acres)	Range of Drainage Areas Upstream of Boundary (acres)
Ephemeral-Intermittent	15.2	6.3 to 45.3
Intermittent-Perennial	40.8	18.0 to 150.1

Field work on aquatic communities was performed by OSM and USGS biologists in some of the same watersheds used for the USGS (2002-Draft) "E-point, P-point" study to assess the potential limits of viable aquatic communities in small headwater streams in southern West Virginia

(Interagency Invertebrate Study 2000). Most of the small streams sampled in the study were not indicated by a blueline on existing 1:24,000 scale USGS topographic maps. The study found that all eight of the target orders of insects selected were found within the headwater reaches evaluated. Furthermore, the study found that a number of taxa that were found in the extreme headwaters have multi-year life cycles. This would suggest that sufficient water is present for long-lived taxa to complete their juvenile development prior to reaching the aerial adult stage in these areas. Although only contiguous flow areas were considered for this study, the field work took place in the winter, and it was considered probable that these extreme headwaters were subject to annual drying.

As part of the work to describe stream conditions in southern West Virginia for this EIS, the EPA found that intermittent streams supported diverse, healthy and balanced invertebrate populations preceding and following a severe drought in the summer of 1999 (USEPA, 2000). During the summer and fall 1999 index periods, many of the reference streams in this EPA study were flow limited, with only trickles of water in their channels, and some of these streams were found to go completely dry. In the spring 1999 index period, preceding the drought, and in the winter 2000 index period, following the drought, all of the intermittent streams could be sampled, and all of the intermittent reference streams were in good or very good condition with diverse and balanced benthic invertebrate assemblages (USEPA, 2000). Clearly these streams, though intermittent for several months in some cases, supported diverse and balanced aquatic life.

b.3. Conclusions Regarding the Existence of Aquatic Communities in Streams Potentially Impacted by Direct Filling or Mining Activities

As can be concluded based on results from the primary literature and from studies performed for this EIS, filling or mining stream areas even in very small watersheds has the potential to impact aquatic communities some of which may be of high quality or potentially support unique aquatic species. It has not been determined if drainage structures associated with mining can provide some benefits (i.e.; increased flows at toe of fills, retaining drainage structures) that could offset aquatic impacts.

c. Loss of Upstream Energy from Buried Stream Reaches

Considerable information regarding the energy cycling functions of headwater streams has been presented in this EIS in Section III.C. The extent to which valley fills eliminate energy resources that may be used by downstream aquatic communities is not well documented. There is a lack of information on the degree to which length of stream directly correlates with the amount of energy in the form of fine-particle organic material or coarse-particle organic material leaving a particular reach of headwater stream. The Value of Headwater Streams: Results of a Workshop, (Appendix D) emphasizes the importance of headwater streams in energy and nutrient spriraling down through a watershed ecosystem. The following is a summary from information provided in Appendix D. Reference citations from primary literature are presented in Appendix D. Forest leaf litter is particularly important to macro invertebrates that process organic matter for downstream reaches. Experiments demonstrate the reliance of stream biological communities on energy inputs from the surrounding forests. When leaf litter was excluded from a stream, the primary consumer biomass in the stream declined, as did invertebrate predators and salamanders. Leaf litter exclusion had a profound effect on aquatic productivity, illustrating the direct importance of terrestrial-aquatic ecotones.

Other experiments illustrated that, although invertebrates and microbiota in headwater streams are only a minute fraction of living plant and animal biomass, they are critical in the export of organic matter to downstream areas by converting leaf litter to fine particulate organic matter, which is much more amenable to downstream transport than the leaves themselves. The extent to which energy loss may be offset by input from reclamation of the mine site and adjacent undisturbed areas is unknown. Impacts that this type of net energy "change" would have on the downstream aquatic environment is uncertain and requires further investigation.

d. Changes in Downstream Thermal Regime

Valley fills have the potential to impact a variety of water quality parameters. One study of thermal impacts of valley fills was performed by the USGS (USGS 2001c) on one stream below a valley fill site and one stream below an unmined site. This study recorded stream temperature at a valley fill site and at an unmined site on a daily basis. Water temperatures from the valley fill site exhibited lower daily fluctuations and less of a seasonal variation than water temperatures from an unmined site. Water temperatures were warmer in the winter and cooler in the summer than water temperatures from the unmined site. Based on the data from this study, it appeared that the maximum daily difference between the two streams was approximately 13.5 degrees Fahrenheit. This study included only two streams so it cannot be determined if the observations made would be true for a number of streams below valley fills. It is also difficult to predict the possible impacts of this moderated thermal regime on the downstream aquatic communities. This issue remains as an uncertainty that requires further investigation.

e. Changes in Downstream Flow Regime

Valley fills have the potential to alter the flow regime of streams downstream from fill areas. One study of the impact of valley fills on stream flows was performed by the USGS (USGS 2001c) on one stream below a valley fill site and one stream below an unmined site, and comparing one flow parameter at many streams with and without filling in the watershed. Low stream flows were investigated by comparing 90-percent flow durations, daily stream flow records, base-stream flows and storm flows. Generally, the 90-percent flow durations at valley fill sites were 6 to 7 times greater than the 90-percent flow durations at unmined sites. Some valley fill sites, however, exhibited 90-percent flow durations similar to unmined sites and some unmined sites exhibited 90-percent flow durations similar to valley fill sites. Daily stream flows from the one valley fill site evaluated generally were greater than daily stream flows from the one unmined site evaluated during periods of low stream flow. The valley fill site evaluated had a greater percentage of base-stream flows and lower percentage of storm flows than did the one unmined site evaluated.

This study included only two streams except for the evaluation of 90-percent flow durations, so it cannot be determined if the observations made would be true for a number of streams below valley fills. It is also difficult to predict the possible impacts of this moderated and elevated flow regime on the downstream aquatic communities. This issue remains as an uncertainty that requires further investigation.

f. Changes in Downstream Chemistry

Mining and associated valley fills have the potential to alter the water chemistry of streams downstream from fill areas. It is possible to relate water chemistry to biological functions of streams where Federal or State Ambient Water Quality Criteria exist.

f.1. Studies Addressing this Impact Factor

The USEPA (2002) conducted a study of the stream chemistry associated with sites classified as mined, unmined, filled and filled/residence. Detailed descriptions of each of the EIS classes were presented in the report. In summary, unmined sites were not located downstream from mines or fills. Mined sites were located downstream of older mine project with no fills, filled sites were located downstream from mined sites with valley fills and filled/residence sites were located downstream from mined, filled sites with residential dwellings in the watershed. The data from this report indicate that MTM/VFs increase concentrations of several chemical parameters in streams. Sites in the Filled category had increase concentrations of sulfate, total dissolved solids, total selenium, total calcium, total magnesium, hardness, total manganese, dissolved manganese, specific conductance, alkalinity total potassium, acidity and nitrate/nitrite. There were increase concentrations of sodium at sites in the filled/residence category which may be caused by road salt and /or sodium hydroxide treatment of mine discharges. Results for all other parameters were inconclusive in comparing among EIS classes.

Comparisons to AWQC were performed with a subset of the total data set as explained in USEPA (2002a). Selenium concentrations from the Filled category sites were found to exceed AWQC for selenium at most (13 of 15) sites in this category. No other site categories had violations of the selenium limit. No other constituents exhibited violations of the AWQC for any category.

In a study conducted in 1998 as part of the National Water Quality Assessment (NAWQA) program of the U.S. Geological Survey, surface water quality was sampled in 12 study areas in the Appalachian Coal Region to measure changes in water quality from baseline conditions that had previously been monitored in 1979-81. Each sample collected during the July-September 1998 sampling period was matched to a 1979-81 sample considered to be most similar in discharge and season. About 180 sites were sampled to assess changes. Sites were selected for sampling on the basis of a three-factor categorical design of geology, mining method, and mining date within the surface drainage basin above each site. Geology was represented by the contrast between the Allegheny-Monongahela River and the Kanawha River Drainage basins. (This corresponds roughly to the northern and southern coal fields in West Virginia terminology.) The mining method was identified as underground, surface, or both. The mining date was identified as before the historical sample, after the historical sample, or both. The reference conditions in both study areas were identified as basins that had never been mined, and particular effort was spent in identifying these basins. While the study did not focus on mountaintop mining specifically, its results are considered relevant to the topic area and are therefore worth reviewing.

The study found that the median pH of summer base flow in these streams increased about 0.5 unit from 1980 to 1998 in both the northern and southern parts of the study area since pH is a logorithmic scale, a change of 0.5 pH is a big change. During the 1998 sample period, the median pH among all sample sites was 7.9 in the north and 7.4 in the south. Alkalinity of the streams also increased and was reflected in decreased concentrations of iron and manganese. These effects would be expected on a regional basis as a result of increased compliance with permit limits and with increasing efforts to control the worst cases of acid drainage from abandoned mines. While improvements in pH, iron, and manganese were seen, median concentrations of sulfate among all sites increased from 38 mg/L to 56mg/L in the north, and from 46 mg/L to 77 mg/L in the south. Sulfate is a good indicator of the total disturbance of a basin by mining and other large scale earth moving activities because most sulfate is produced by oxidation of pyrite minerals to acidic iron sulfate, and these types of activities increase the amount of pyrite minerals that are available for oxidation. Among 52 basins where mining occurred both before and after 1980, for example, the sulfate concentration more than doubled in 13 basins, including greater than five-fold increases in 5 basins. In both northern and southern basins, sulfate concentrations of less than 20 mg/L were common in unmined areas. Acid loads from the pyrite reaction are neutralized at a regional scale by both alkaline minerals naturally present in mined areas and by engineered additions of alkalinity. Acid production will continue, however, in proportion to the amount of available pyrite, and after mining ends, acid production will gradually decrease as the amount of pyrite is consumed.

A study was also conducted by OSM on the cumulative off-site impacts from a large area mine in southeastern Ohio over a twelve year period. The location of the study was on the Central Ohio Coal Company (COCCO)property where a dragline was used. OSM used the 1980 data submitted by COCCO and data collected between 1987 and 1999 by the Ohio Environmental Protection Agency (OEPA) to evaluate the impacts. Although this study was not in this EIS study area it was included to show how mining activities without valley fills can impact water quality. The chemical analysis of the impacted streams indicated similarly elevated levels of hardness, sulfates and conductivity as did the EPA 2002 study. (USDOI OSM 2000)

f.2. Summary and Conclusions

In summary, mining and valley filling activity appear to be associated with some downstream changes in surface water chemistry. These changes include increases in a number of cations that are known to be associated with surface mining such as sulfate, total dissolved solids, total calcium, total magnesium, hardness, total manganese, dissolved manganese, specific conductance, alkalinity, and total potassium. The majority of these constituents may also increase in many other types of large scale earth moving activities.

In the USEPA (2002a) stream chemistry study, selenium was found to exceed AWQC at Filled sites only, and was found to exceed AWQC at most Filled sites included in the study. The existence of selenium at concentrations in excess of AWQC at most of the filled sites indicates a potential for impacts to the aquatic environment and possibly to higher order organisms that feed on aquatic organisms.

While changes in water chemistry downstream from mined, filled sites have been identified, it is not known if these changes are resulting in alterations to the downstream aquatic communities or whether functions performed by the areas downstream areas from mined, filled sites are being impaired. Question exist as to how the downstream chemistry is affected by factors such as time, method of mining, reclamation practices and size of operation. Further evaluation of stream chemistry and further investigation into the linkage between stream chemistry and stream biotic community structure and function are needed to address the existing data gaps.

g. Changes in Downstream Sedimentation (Bed Characteristics)

Valley fills have the potential to alter geomorphological features of streams downstream from fills such as sediment particle size. One study of the impact of valley fills on sediment particle size was performed by the USGS (USGS 2001c). Particle sizes were measured at 54 small stream sites in four watersheds. Valley fill sites had a greater number of particles less than two millimeters in size, a smaller median particle size and about the same 84th percentile particle size as compared to the mined and unmined sites. Results were based on visual comparisons of box and whisker plots developed for each data class.

Similar results on sediment particle size at stream sampling stations below fills were obtained from USEPA (2000). Valley fill sites had a greater number of particles less than two millimeters in size and a smaller mean particle size. However, the mean substrate size class was found to be very similar between unmined, filled, filled residential and mined EIS class sites. The authors stated that these data indicate that the valley fills do not seem to be causing excessive sediment deposition in the first and second order streams that were sampled but cautioned against generalizing this finding to higher order streams or to reaches downstream in these watersheds. In contrast, sampling downstream of mountaintop mining/valley fill sites in Kentucky revealed greater sediment deposition and smaller substrate particle sizes than in reference streams (EPA 2001).

In the OSM study of Central Ohio Coal Company (COCCO) property, stream habitat was evaluated in 1987 and 1999 using OEPA's Qualitative Habitat Evaluation Index (QHEI). The author stated that the QHEI may be somewhat subjective, but it is still a good indicator of habitat quality. The QHEI indicated impairments from heavy to moderate silt cover and substrate embeddedness in two streams studied in 1987. However, the 1999 sampling showed that the streams had improved sufficiently to support warm-water biota (USDOI OSM 2000).

While these studies illustrate that mining and valley fills may alter the sediment composition of streams, it is not known if this change may impact functions of streams downstream or how long these changes may persist. Assessment of stream sediment characteristics should be included in any further evaluations or monitoring program for streams downstream from mining and valley fills.

h. Effects to Downstream Biota

MTM/VFs have the potential to impact aquatic biota since mining and filling activities may occur within streams. A review of the literature available for this EIS on this topic has revealed that there are at least four types of studies which have been performed to evaluate the impact of mining in general and MTM/VF in particular on aquatic macroinvertebrate biota. These four types of studies include: A. Comparisons of results from stream sites upstream of mine input to downstream results; B. Comparisons of Pre-mining results to post-mining aquatic community results; C. A multivariate analysis study on a regional basis of potential impact producing factors to stream systems; and D. Studies of stream sites located downstream from mined or valley filled areas in comparison to reference locations.

Several studies evaluating the potential impacts of mining or mined-valley filled areas on fish communities address the issue of potential impacts of mining and associated fills to aquatic biota. These studies have been summarized below.

Most studies evaluated basic water chemistry and field water chemistry parameters, and habitat characteristics including substrate conditions. Stream order was included as a criteria for establishing the study but was not evaluated further in most cases. Neither the size nor age of mining or associated fills were included as evaluation criteria in any study summarized here.

h1. Summary of Results from Upstream-Downstream Comparison Type Studies

Four studies of this type were made available for use in this EIS from coal companies, particularly from Pen Coal Corporation. These studies included studies evaluating macroinvertebrate communities downstream from mine influences to upstream sites for Twelvepole Creek (Pen Coal 1998; Pen Coal, 2000c), Honey Branch (Pen Coal, 1999a) and Trough Fork Creek (Pen Coal, 2000a). These studies assessment evaluation metrices relating to the abundance, number of taxa, proportion of sensitive species present, and diversity and evenness of the aquatic macroinvertebrate community at stream sampling locations above and below the influence of mining. Usually water chemistry and habitat characteristic evaluations were performed in concert with the biotic evaluation.

Overall, the abundance of macroinvertebrates was found to be similar in upstream and downstream stations or to be slightly higher in downstream stations. As discussed in these studies and other studies (see Arch Coal in prep 2002), this increase in abundance may be related to the presence of releases from sedimentation ponds or other releases of solids into the stream. The number of taxa were found to be similar in upstream or downstream stations or to decrease at downstream locations near to the influent area from the mines. The largest difference seen between upstream and downstream locations was the change in proportion of sensitive groups. All four studies reported a decrease in the proportion of sensitive organisms in the stream sampling locations downstream from the mining influent. In addition, other metrices that evaluate the diversity, evenness and degree of pollution tolerance of the aquatic community were found to become more indicative of an impacted stream condition (i.e. diversity and evenness decreased, pollution tolerance increased).

Two types of physio-chemical factors were singled out by these studies as potentially contributing to these community changes. Several studies indicated that sedimentation was greater downstream from the point of mine influent. All studies noted increases in the water chemistry parameters sulfate, conductivity and hardness. Selenium was not an analyte in any of these studies.

These studies did not specifically address the presence of or potential impacts from valley fills. Given the current status of these studies, fills were probably part of the mine complexes evaluated by these studies but it is not known whether all downstream locations in these studies were downstream from fills or just from mining areas.

h2. Results of Comparisons of Pre-mining Biotic Conditions to Post-mining Aquatic Communities

Two studies comparing pre-mining biotic conditions to post-mining aquatic communities from the same stream sampling locations were made available for use in this EIS from coal companies, particularly from Pen Coal Corporation. These studies included studies on Trough Fork (Maggard and Kirk, 1999 and Pen Coal, 2000a), and Honey Branch (Pen Coal,1999a). These studies assessed evaluation metrices relating to the abundance, number of taxa, proportion of sensitive species present, and diversity and evenness of the aquatic macroinvertebrate community at stream sampling locations before mining was initiated and after or during the development of a mine. Usually water

chemistry and habitat characteristic evaluations were performed in concert with the biotic evaluation.
The evaluation for Honey Branch was complicated by the fact that the historic data from 1987 appeared to have been derived from sampling performed using different sampling techniques than are currently employed. The authors of this report stated that a qualitative comparison of current to past results suggests that the aquatic macroinvertebrate community has undergone a shift to a more tolerant, less sensitive community.

The evaluation of Trough Fork is an ongoing project. Sampling was initiated in 1995 prior to mine initiation. This study included sampling sites upstream and downstream from the influent from the mine complex. Between 1995 and 1999 the upstream sampling locations showed increases in abundance, taxa richness, the number of EPT genera and slight decreases in the proportion of sensitive organisms and community diversity. These changes may reflect the natural variation present in aquatic communities over time since there should be no direct effects from mining input to the upstream stations. Changes in the downstream station were similar to those seen at the upstream station for abundance and taxa richness. However, the diversity and evenness of the downstream macroinvertebrate communities decreased notably and the proportion of tolerant organisms increased notably in comparison to the 1995 results and the upstream station.

Water chemistry did not change much between the 1995 and 1999 sampling periods for the upstream sampling station. However, for the downstream sampling station, increases in conductivity, TDS, TSS, hardness, alkalinity, sulfates, sodium, calcium and magnesium were found the 1999 sampling period compared to the initial 1995 results. Selenium was not included as an analyte in these samples.

Anecdotally, the investigator noted that base flow had increases at the downstream location. The report stated that this should have a positive impact on the aquatic community, but results from the 1999 sampling period do not appear to indicate that a positive change is occurring at the stations downstream from the mine (Maggard and Kirk, 1999).

These studies did not specifically address the presence of or potential impacts from valley fills. Given the current status of these studies, fills may not be complete at this point. This on-going project represents an opportunity to investigate the relationship between fill age and downstream impacts.

h3. Results of A Multivariate Analysis Study on Benthic Invertebrate Communities and Their Responses to Selected Environmental Factors

An extensive study of invertebrate communities and their responses to environmental factors in the Kanawha River basin was performed by the USGS (USGS, 2001a). This study included in entire Kanawha River basin and, on a regional basis, focused on relationships between macroinvertebrate community characteristics with land use types and other stream-related factors such as stream chemistry and habitat characteristics. A variety of multivariate statistical analyses were used to explore the potential relationships among variables.

Results from this study indicated that in the Kanawha River Basin the effects of coal mining, such as changes in stream water chemistry and benthic habitat quality, strongly shaped aquatic macroinvertebrate communities especially in basins of less than 128 square miles. Coal mining appeared to influence invertebrate communities through two factors: 1. Increasing habitat degradation through decreasing the median particle size of streambed material, and 2. Increasing the specific conductance and sulfate concentration of surface water. On a positive note, this study found little evidence of classic acidic mine drainage in the Kanawha River Basin.

The increase in specific conductance and sulfate concentration was associated with a proportional decrease in the sensitive taxa in the stream macroinvertebrate communities. The study also indicated that the decrease in median particle size of streambed sediment was the habitat characteristic that most strongly correlated to loss of sensitive taxa groups and increases in tolerant taxa. It was noted that other landscape level alterations such as large construction projects and stream dredging also decreased median particle size.

While this report did not focus on valley fills, potential impacts from valley fills to stream chemistry and possible alterations to stream geomorphology were discussed as areas in need of further investigation.

h4. Studies of Macroinvertebrate Communities in Stream Sites Located Downstream From Mined or Mined/Valley Filled Areas in Comparison to Reference Locations

A fourth type of study is available relating to the potential impacts of mining and valley filling on downstream aquatic invertebrate communities. Typically, these studies evaluated stream communities located downstream from mining plus valley fills, or mining alone in comparison to various reference locations.

This type of study originated with the USEPA (2000) study of numerous watersheds throughout the MTM/VF study area. A followup to this study using a variety of comparative statistical approaches is being prepared by the USEPA (2002 in prep). Also in preparation is a supplemental study of the sampling stations used in USEPA (2000) relating to mining performed by Arch Coal, Inc. A draft version of this report was released in August of 2000 but Arch Coal has indicated that a revised version of this report will be released shortly (Arch Coal, conference call of May 29, 2002). A supplemental evaluation of sampling stations used in USEPA (2000) relating to valley fills in the vicinity of the Hughes Branch was developed by Cannelton Industries (Cannelton, June 2000). Finally, EPA Region 4 has completed an evaluation of the impacts of MTM/VF to streams in Kentucky (USEPA Region 4, 2001).

Summary of the USEPA Stream Survey Study

The EPA streams study (USEPA 2000) was performed as part of this EIS to more fully evaluate what changes, if any, are occurring in benthic communities, stream chemistry, and aquatic habitat downstream of mining operations. These studies were designed for the express purpose of providing a synoptic description of stream conditions in five representative watersheds across the primary mountaintop mining area within the study area. These watersheds were defined by the West Virginia Geological and Economic Survey (WVGES) and include Twentymile Creek, Clear Fork, Island Creek, Mud River, and Spruce Fork.

The selected study sites were monitored for benthic macroinvertebrate populations, water chemistry, and physical habitat when adequate flows allowed. Benthic macroinvertebrate populations were sampled in the five study watersheds using the RBP single habitat sampling protocol (USEPA 1999). Samples were collected over a period of five seasons: spring 1999, summer 1999, fall 1999, winter 2000, and spring 2000. Most of the unmined streams could not be sampled during the summer and fall 1999 sampling seasons due to stream flows being either too low to allow benthic sampling or the streams lacked flows altogether.

Methodology and results of the invertebrate component of the stream study are reported in the draft report "*A Survey of the Condition of Streams in the Primary Region of Mountaintop Mining/Valley Fill Coal Mining*", dated November 2000.

The primary objectives of this study relating to the impact of MTM/VF on stream communities were:

1. Characterize and compare conditions in three classes of streams: 1) streams that are not mined (termed "unmined"); 2) streams in mined areas with valley fills (termed "filled"); 3)streams in mined area with valley fills and residences (termed "filled-residential") and 4) streams in mined areas without valley fills (termed "mined").

2. Characterize conditions and describe any cumulative impacts that can be detected in streams downstream of multiple fills. Owing to conditions encounter no definitive conclusions were reached regarding this second objective.

This study evaluated benthic macroinvertebrate assemblage data, physical stream habitat assessments, quantitative estimates of substrate size, and limited field chemical/physical parameters.

Biological conditions in the unmined sites generally represented a gradient of conditions from good to very good, based on the WVDEP SCI scores. These sites are primarily forested, with no residences in the watersheds. One site scored in the high-end of the fair range in the summer of 1999, one site scored in the poor range in the fall of 1999, and one site scored in the high-end of the fair range in the winter of 2000. The authors believes these sites scored lower primarily because the drought and lower flows impeded their ability to collect a representative sample. They observed no other changes at these monitoring sites that could account for the changes in the condition of the streams, other than the low flows. When these sites were sampled in later index periods, they scored in the good or very good range.

Biological conditions in the mined sites generally represented very good conditions, although a few sites did score in the good and poor range. One site that scored in the poor range was believed to be naturally flow-limited even during periods of normal flow. The authors believed this site was ephemeral and only flowed in response to precipitation events and snow melt. The other mined sites generally had only a small amount of mining activity in their watersheds.

Biological conditions in the filled sites generally represented a gradient of conditions from poor to very good. One site scored in the very poor range in the spring of 2000. Over the five seasons, filled sites scored in the fair range more than half of the time. However, over a third of the time, filled sites scored in the good or very good range over the five seasons. The authors believe water quality explains the wide gradient in biological condition at the filled sites. The filled sites that scored in the good and very good range were found to have better water quality, as indicated by lower median conductivity at these sites. The filled sites that scored in the fair, poor and very poor ranges had degraded water quality, as indicated by elevated median conductivity at these sites.

Biological conditions in the filled/residential sites (filled sites that also have residences in their watersheds) represented a gradient of conditions from poor to fair. Over the five seasons, filled/residential sites scored in the poor range more than half of the time. The remainder of the filled/residential sites scored in the fair range. No sites in the filled/residential class scored in the good or very good range. All sites in the filled/residential class had elevated median conductivities.

In general, the filled and filled/residential classes had substantially higher median conductivity than the unmined and mined classes. It is important to note that the filled sites generally had comparable or higher conductivity than the filled/residential sites within a watershed, indicating that the probable cause of the increase in the total dissolved solids at the filled/residential sites was the mining activity upstream rather than the residences. Presently, there are no aquatic life criteria for conductivity or total dissolved solids.

Biological conditions in the filled and filled/residential classes were substantially different from conditions in the unmined class and were impaired relative to conditions in the unmined class, based on the WV SCI scores.

The filled/residential class was the most impaired class. The causes of impairment in this class could include several stressors (e.g. the valley fills, the residences, roads). It is impossible to apportion the impairment in this class to specific causes with the available data.

The general patterns of stream biological condition presented in the previous paragraphs were clear in all three seasons that have complete data sets (spring 1999, winter 2000 and spring 2000)including sampling results from unmined sites.

The Rapid Bioassessment Protocols habitat assessment data did not indicate substantial differences between the stream classes. The habitat in the filled class and the filled/residential class was slightlydegraded relative to the unmined class. Individual sites in the filled and filled/residential classes had degraded habitat and excessive sediment deposition.

In general, the substrate characteristics of the filled, filled/residential, and mined classes were not substantially different from the unmined class. The data from this study did not indicate excessive fines in the filled or the filled/residential classes as a whole, however, there were specific sites within these classes with substantially higher percentages of sand and fines compared to the unmined class. It should be noted that many of the filled sites were established in first and second order watersheds in order to limit the potential stressors in the watershed to the valley fills. These data indicate that the valley fills and associated mining activity did not cause excessive sediment deposition in the upper reaches of these watersheds. The authors noted that it would not be appropriate to extrapolate this conclusion to reaches farther downstream in these watersheds or to larger order streams.

Correlations in this study between the benthic metrics and selected physical and chemical variables indicated that the strongest and most significant associations were between biological condition and conductivity. Physical habitat variables were more weakly correlated with biological condition and some of these associations were not significant. Water quality appeared to be the major factor limiting the benthos in the impaired streams. This study also discussed findings related to flow and noted that perennial flow conditions were not needed to support high quality aquatic communities.

Summary of the Other Studies Relating to Impacts of MTM/VF on Stream Biota

A followup to the USEPA (2000) study using a variety of comparative statistical approaches is being prepared by the USEPA (2002 in prep). This study is analyzing data from the USEPA report along with data provided by various coal companies. Thus far, preliminary results, using only those sample periods from all sites where flow was sufficient to allow sampling, support the findings of the USEPA (2000) study. The Filled and Filled-Residential sites have been found to differ significantly from the unmined and mined sites in six to nine of the nine evaluation metrices. All differences observed are in the direction of impairment (e.g., decreased diversity, increase proportion of tolerant organisms in the community etc).

In preparation is a supplemental study of the sampling stations used in USEPA (2000) relating to mining performed by Arch Coal, Inc. A draft version of this report was released in August of 2000. Arch Coal presented some preliminary results from the revised version of this report in a teleconference (Arch Coal, conference call of May 29, 2002 and 2000). Based on this presentation, results appear to be similar to those in USEPA (2000). Arch Coal found filled and Filled-Residential sites showed decreases in EPT taxa and increases in the proportion of tolerant organisms in the community compared to reference sites. This study also measures abundance but results on this evaluation metric are not yet available for inclusion in the EIS. In their evaluation of physio-chemical parameters that might explain community changes observed, Arch Coal noted that the moderated thermal regime may have increase the degree-date accumulation of the stonefly populations resulting in emergence earlier in the season than had previously been observed. Although it is not known if such a change would result in changes to the community, it is interesting to note that changes to the thermal regime downstream from valley fills may be exhibiting a population level impact.

A supplemental evaluation of sampling stations used in USEPA (2000) relating to valley fills in the vicinity of the Hughes Branch was developed by Cannelton Industries (Cannelton, June 2000). This study looked at three stations below valley fills and other mining influences. These stations were evaluated using the WV SCI. SCI results ranged from good to very good. This study also found very low percentages of mayflies (ephemeroptera) at this sites and elevated surface water conductivity, hardness and sulfates. All findings presented were similar to the findings of the USEPA (2000) study.

EPA Region 4 conducted a one time sampling of streams in Kentucky and evaluated those samples for impacts from MTM/VF. This study compared sampling stations located downstream from mined-filled areas to reference streams. Severe impacts to the mayfly fauna was exhibited at all mined-filled sites. Decreases in pollution-sensitive macroinvertebrates were also observed at mined-filled sites. Also, decreases in taxa diversity were observed at mined-filled sites. Mined-Filled sites generally had higher conductivity, greater sediment deposition, and smaller substrate particle sizes. Strong negative correlations were observed between conductivity and indications of macroinvertebrate community health. (USEPA 2001)

OSM Report on the Cumulatative Off-Site Impacts from a Large area Mine in Southeastern Ohio.

OSM conducted a study of a Central Ohio Coal Company (COCCO) mine in Southeastern Ohio to determine the off-site impacts from a large area mined. This study, although not in this EIS study area, provides information to consider if the cause of the impacts being seen below MTM/VF studies were due to the SMCRA defined "valley fills" or could be expected from area mining "backfill". The study used both COCCO's samples from 1980 and Ohio Environmental Protection Agency (OEPA) samples from 1987 and 1999. The preponderance of the mining was done post-1972 (SMCRA) and completed in 1987 (Rannells Creek) and 1992 (Collins Fork).

OSM obtained fish study results, macroinvertebrate study results, water quality analysis, and Quality Habitat Evaluation Indicators (QHEI) from the OEPA samplings. Comparative surveys of macroinvertebrates on Collins Fork and Rannells Creek indicate similar results to those in the filled and filled/residence class sites of MTM/VF studies (i.e.; elevated conductivity, sulfates, hardness and a decline in pollution sensitive species). Evaluations of the invertebrate community quality appeared unchanged between the two OEPA sampling periods. It is particularly noteworthy that none of the macroinvertebrate samples in 1987 or 1999 showed any significant numbers or kinds of mayflies. This absence of mayflies has also been observed in recent surveys by the USEPA 2002 study in West Virginia in mining areas with acceptable pH's, but with high conductivities. (USDOI 2000)

i. Impacts of MTM/VF on Fish Assemblages

Two studies relating fish communities to potential impacts from mining and or mining and valley filling are available for use in this EIS. The USFWS MTM Fish Assemblage Characterization Report (Stauffer and Ferreri, 2002) directly addressed this issue.

An extensive study of fish communities and their responses to environmental factors in the Kanawha River basin was performed by the USGS (USGS 2001b). This study included in entire Kanawha River basin and, on a regional basis, focused on relationships between fish community characteristics with land use types and other stream-related factors such as stream chemistry and habitat characteristics. A variety of multivariate statistical analyses were used to explore the potential relationships among variables.

The USGS (2001b) found that stream size and zoogeography masked any potential water quality effects of land use on species composition and relative abundance of fish communities in the study. This and other factors relating to natural characteristics of fish communities in this region limit the usefulness of this study to evaluate mining impacts on fish communities.

Stream Fish Assemblage Characterization

There is little historical information regarding stream fish populations in the primary region of mountain top removal/valley fill coal mining. To address this data gap, fish communities at several pre-selected sites in the MTM/VF study area were sampled (Stauffer and Ferreri, 2002). The objectives of this study were to 1) characterize the fish communities that exist in the primary region of mountain top removal/valley fill coal mining in West Virginia and Kentucky, 2) determine if any unique fish populations exist in this area, and 3) evaluate the effects of these mining operations on fish populations residing in downstream areas.

During 1999-2000, fish assemblages were sampled in 58 sites in West Virginia located on 1st through 5th order streams, and in 15 sites in Kentucky located on 2nd, 3rd, and 4th order streams. The majority of the sample sites were selected in consultation with personnel from U.S. Environmental Protection Agency (USEPA) Region III and Region IV. A few sites were added in the field to enhance the characterization of the fish communities in the primary region of mountain top removal/valley fill coal mining. Sites in West Virginia were assigned an EIS Classification based on U.S. EPA Region III classification. Sites in Kentucky were assigned an EIS Classification based on Region IV classifications. Two sites, Stations 6 and 22 (a 2nd order and a 4th order stream) in the Mud River watershed, were sampled during each year, and it was determined that collections at these sites were comparable between seasons. However, results from the 1999-2000 sampling effort indicated that there were not enough reference sites to adequately assess the potential effects of mountain top mining/valley fill operations on fish communities in the area. A strong relationship was found between stream size (as described by stream order) and the total number of fish species present. All of the unmined sites that were to serve as reference sites were located on 1st and 2nd order streams, while sites classified as mined, filled, filled/residential, and mined/residential occurred primarily on 3rd and 4th order streams making direct comparisons between mined and filled sites inappropriate. As a result, in Fall 2001, eight sites in the Mud River that were classified as filled or filled/residential were re-sampled along with five sites in the Big Ugly and three sites in the Buffalo Creek drainages that were chosen to serve as reference (of the unmined condition) sites in the Guyandotte River system.

Due to the confounding effects of drought, small stream size (low stream order), and human impact on reference sites in West Virginia, reference (unmined) sites could not be directly compared to filled sites directly during the 1999/2000 sampling season. Thus, results were developed based on Kentucky sites and 2nd order streams in the New River Drainage where comparable reference (unmined) and filled sites were available. Comparison of unmined sites and filled sites in Kentucky and in 2nd order streams in the New River Drainage indicate that mountain top removal/valley fill coal mining has had an impact on the condition of streams. In general, the number of total species and number of benthic fish species were substantially lower in filled sites than in mined sites in both Kentucky and 2nd order streams in the New River Drainage.

In 2001, the fish samples taken in the mined sites in the Mud River were compared with reference sites sampled in the Big Ugly drainage. Both the Mud River and Big Ugly rivers are part of the Guyandotte River system. Both the total number of species and the total number of benthic fish species were greater in the reference sites (median 17 and 6 respectively) than in the filled sites collected in 2001 (median=8 and 1.5). The total number of species collected during 1999/2000 was considerable higher (median = 12.5) than the total number of species collected at the same sites in 2001 (median 8). Water chemistry analysis revealed that five of the Mud River sites sampled in 2001 had detectable levels of selenium (9.5 - 31.5 µg/l). Filled sites that were associated with detectable levels of selenium seemed to be more impaired than filled sites that had no detectable levels of selenium. Total number of benthic fish species in reference sites (median=6) was higher than those recorded in filled sites with selenium (median = 0) and without selenium (median = 3). The fisheries study noted that a multiple year collecting regimen would be needed to see if there continues to be a decrease in the number of species over time in the filled sites.

This study did not address whether there are environmental benefits of sustained flows from filled watersheds when compared to no-flow conditions in some unmined reference streams. It is possible that the altered flow regimes found downstream from valley fills (USGS 2001) may affect fish habitat for parts of the year in those cases where fish habitat had been previously limited due to seasonally dry conditions. It is also possible that potential benefits from increased flows downstream of mountaintop mining/valley fill operations are offset by changes in water quality. For example, fish collected from one lake downstream of an extensive mining complex in West Virginia were found to contain selenium concentrations much higher than would be expected to occur naturally, indicating that the selenium associated with mining operations occurs in a form that is biologically available for uptake into the food chain (U.S. FWS, unpublished data).

2. Studies Relating to Mitigation Efforts for MTM/VF Impacts to Aquatic Systems

Surface mining operations in steep slope terrain generate excess spoil that is often placed in adjacent valleys. These valley fills encroach and bury headwater stream habitats, and potentially impact stream conditions downstream from fills. Past efforts at compensatory mitigation have not achieved a condition of no-net loss of stream area or functions.

a. Definition of Mitigation

Stream habitat and functions lost through mining and filling are subject to amelioration through mitigation. The Council on Environmental Quality (CEQ) has defined mitigation in its regulations at 40 CFR 1508.20 to include: avoiding impacts, minimizing impacts, rectifying impacts, reducing impacts over time and compensating for impacts. These can be summarized into three general types: avoidance, minimization and compensatory mitigation [MOA between US Army Corps of Engineers and EPA (EPA 1990)]. The objective of compensatory mitigation for unavoidable impacts is to offset environmental losses.

Where mining and filling activities have impacted streams compensatory mitigation may be used to replace lost habitat and functions. Compensatory actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands) should be undertaken when practicable, in areas adjacent or contiguous to the discharge site (on-site compensatory mitigation). If on-site compensatory mitigation is not practicable, off-site compensatory mitigation should be undertaken in the same geographic area is practicable (i.e., in close physical proximity and to the extent possible the same watershed).

b. Mitigation Goals

In determining compensatory mitigation, the functional values lost by the resource to be impacted must be considered. Functional values should be assessed by applying aquatic site assessment techniques generally recognized by experts in the field and/or the best professional judgment of federal and state agency representatives, provided such assessments fully consider ecological functions in the Guidelines. The ecological functions of Appalachian streams are described in Chapter III.C. Headwater streams receive, process and transport a major portion of the downstream biological energy budget from leaf litter and other terrestrial sources of carbon. Downstream biological communities are adapted to existing physical, chemical, and biological conditions within these stream arrays

Headwater streams provide habitat for lotic aquatic communities. Generally, in-kind compensatory mitigation is preferable to out-of-kind. Replacement of a mined for filled stream by restoration or creation of a similar type of stream would be more in keeping with this policy than would replacing stream systems with palustrine wetland systems.

In addition, the areal extent of impacts must be considered in the development of successful mitigation efforts.

c. Requirements for Development of a Successful In-kind Replacement Mitigation Project

Stream re-creation is a young but advancing science. In order for streams to be successfully re-created or restored, a range of natural variables must be integrated into the design including: hydrology, hydraulics, water quality, fluvial geomorphology, sediment transport mechanics, plant ecology, macroinvertebrate and fisheries biology and land use (Inter-Fluv 1998). In addition, to mitigate for values lost, size of the mitigation project must be considered.

d. Limiting Factors for In-kind Mitigation Projects

Past efforts at stream construction in association with mine restoration have found limitations in each of the parameters needed for a successful in-kind mitigation effort for headwater streams.

Stream creation on filled areas is very difficult in general due to the inability to capture sufficient groundwater flows necessary to provide a source. There is some suggestion that perennial flow could be established on a contour between the fill and the native rock by the use of some type of impermeable liner. However, no demonstration projects have yet been performed to validate this hypothetical design. Speakers at the Aquatic Ecosystem Enhancement at Mountaintop Mining Sites Symposium (Appendix D) concluded that, at best, streams recreated on mined lands would be expected to have only intermittent flow. As discussed in the USEPA Stream Chemistry Report, several chemical parameters have been found to be elevated in stream surface water downstream from filled/mined areas (USEPA 2002a). Chemical parameters elevated in excess of ambient water quality criteria may impair the aquatic productive of constructed streams.

Post-mining land use surrounding any restored stream would influence the potential functions of that stream. The cumulative impact study (USEPA 2002) found that over 80% of first to third order streams in the EIS study area are surrounded by forest. The cumulative impact study also found that land use for post-mining areas was primarily grasslands. Restored mined areas do not rapidly develop forest cover. This change in surrounding land use represents a factor that may impact the successful restoration of stream functions from a constructed stream.

Establishing aquatic communities of stream-dwelling organisms in restored or created streams depend on the extent to which the physical and chemical environment needed by these organisms has been re-created. It is possible that the elevated flow regimes found downstream from valley fills (USGS 2001) may have created additional fish habitat for parts of the year where previously fish habitat had been limited owing to seasonally dry conditions. It is not known if this increase in stream length used by fish would be equated to greater fish product or simply represents an increase in area where fish are found.

During the development of this EIS, technical representatives from OSM and from West Virginia have suggested that groin ditches constructed along the edges of fills may represent an opportunity for in-kind replacement of streams with an intermittent or ephemeral flow regime. To date, no drainage structures observed appear to have successfully developed into a functional headwater stream (Appendix D). As discussed in the Aquatic Ecosystem Enhancement at Mountaintop Mining Sites Symposium (Appendix D), creating a more natural channel, increase the structural complexity in the mitigation design by adding boulders, logs and snags and encouraging the restoration of native plant species along a created channel such as a groin ditch would increase the potential for a successful stream creation project. However, the overall limitation to the re-construction of streams in mined and filled areas appears to be the associated with establishing suitable hydrology.

Creation of other ponds and wetland resources on mined land has shown more promise. Wallace (EPA 2000) suggested that these types of systems can be important sites of nutrient storage and uptake provided that a sufficiently vegetated littoral zone is present.

e. Types of Out-of-kind Mitigation

e.1. Onsite

The majority of past efforts at on-site mitigation have been aimed toward the development of palustrine wetland systems to replace streams destroyed through mining and valley filling activities. A review of National Wetland Inventory mapping in conjunction with status and trends information for the study area indicates that natural wetland areas typically found in the steep slope region are generally narrow linear vegetated wetlands along the stream valleys. Wetland areas are being created on reclaimed mine sites. Because steep slope areas are being flattened, it is anticipated that wetland acreage has actually increased as a result of these mining activities.

A number of studies have been performed to evaluate the functions provided by wetlands that have developed on, or been constructed on, mined and filled sites (Pen Coal, 1999 and USEPA, 2000). The results of two of these studies are summarized below.

While wetland areas may be forming on mined sites, the functions being provided by these areas are largely unknown. A technical study was performed by the USEPA to address this issue (USEPA, 2000). Field surveys were performed in November 1999 on ten wetland sites (mainly linear drainage structures and basin depressions) to assess the water quality, wildlife, and sediment trapping functions being provided by wetland areas typically being created on mined lands. The Evaluation for Planned Wetlands technique developed by Environmental Concern, Inc. (USEPA, 2000) was utilized by the field teams to perform these field assessments. The results for three habitat quality descriptors were based upon a score of 0 to 1 (lowest to highest).

Three parameters were evaluated in this study including sediment stabilization, water quality and wildlife. Sediment stabilization is the capacity to stabilize and retain previously deposited sediments. The water quality function is the capacity to retain and process dissolved or particulate materials to the benefit of downstream surface water quality. The wildlife parameter is the degree to which a wetland functions as habitat for wildlife as described by habitat complexity. Many of the wetland systems were providing excellent sediment stabilization functions, and a few were providing good water quality and wildlife functions. These findings are expected. Generally speaking, sediment stabilization is not a difficult function to establish in a wetland system. Water quality functions are also possible to establish with modest planning. In many of these cases, we suspect that the wetland systems were largely unplanned, and that the low percent vegetative cover was a significant influence on the low degree of water quality function being provided. Finally, wildlife functions are highly dependent on the vegetative communities present, the degree of interspersion, and other physical and biological features of the system. It is not surprising, therefore, to see that this function did not score highly in many of the systems studied. Those areas that scored highly for wildlife function tended to be older systems with more complex structures. It should be noted that the wetlands studied represented wetlands with surface water connects to stream systems as well as isolated wetlands which lacked connectivity to stream systems.

A study conducted by Pen Coal, entitled *An Evaluation of the Aquatic Habitats Provided By Sediment Drainage Ditches and Sediment Control Ponds Located on Mine Permitted Areas in Southern West Virginia* (Pen Coal, 1999), examined the water chemistry and biological communities located in sediment control structures. Three sediment ponds and three sediment ditches were studied. When comparing total abundances and taxa between the ponds, the study found that two of the ponds contained large total abundances of aquatic insects and a desirable number of taxa. One pond contained relatively low abundances and low taxa diversity compared to the other ponds sampled, but this pond had only recently been constructed and may have not yet established an aquatic community. Similar results were found in the sediment ditches. One recently constructed ditch contained a low abundance but moderate taxa diversity. The other ditches contained moderate and high abundances and varied taxa diversity (one was high and the other low). In general, most of the ponds and ditches sampled were well represented by the groups of aquatic insects which are normally present in these lentic habitats. The functional feeding groups scrapers and collecters/filterers were never present, but this was not surprising since these groups need silt free environments and faster moving water. The shredder functional feeding group (those that consume leaves and other detrital material) was also not well represented, but this group is sensitive to disturbances and pollution. Alternatively, the ditches may have lacked an adequate food supply for shredders. Generally, the sites contained mostly tolerant organisms such as midges, dragonflies, and aquatic worms which can tolerate pond habitats.

While the results of this study indicate that the sediment control structures are not functioning as healthy headwater streams based upon metrics commonly used to make such an assessment, it should not be automatically assumed that these systems are of little value to downstream resources. Some nutrient cycling functions may occur in these wetlands. Merritt et al. (1984) summarized the nutrient resource utilization in a variety of aquatic habitats including headwater streams, eutrophic lakes and temporary ponds and discussed that aquatic insects in freshwater ecosystems played a role in the processing, turnover, storage and cycling of nutrients in all systems. However, published studies demonstrating the occurrence of this function in wetlands established on mining sites are lacking.

In summary, to date functioning headwater streams have not been re-created on mined or filled areas as part of mine restoration or planned stream mitigation efforts. Most on-site mitigation construction projects have resulted in the creation of palustrine wetlands that resembled ponds. Some of these created wetlands are isolated from other surface water systems while others occur in drainage channels which connect to the original stream system at some point. On some fills, linear-shaped wetlands may develop in groin ditches. Functions potentially restored or replaced by these wetlands include sediment stabilization, wildlife support and water quality maintenance. Functions not restored include habitat for aquatic organisms that require lotic or flowing-water conditions. Palustrine wetlands are known to process organic material which may be transported to downstream if the wetland connects to the original stream. However, it is not known whether the organic matter processing that occurs in created wetlands would mimic the processing found in a natural stream system. Functions of man made ponds and wetlands exist and may be considerable. While these functions differ from those of headwater streams, these functions do have their own inherent values. In fact, the establishment of ponds or wetlands on benches or at the toe of mined areas may tend to limit the effect of disturbances on the downstream watersheds (Appendix D: Wallace).

e.2. Offsite

Past efforts by the states in the MTM/VF Study area to initiate offsite compensatory mitigation practices are discussed below. However, past efforts at off-site compensatory mitigation have not achieved a condition of no-net loss of stream area or functions.

West Virginia Mitigation Prior to 1998

The WVDEP indicates that on-site mitigation of stream impacts was not the norm for pre-settlement MTM/VF mining operations in West Virginia. The threshold for wetland mitigation was 1/3 acre of impacts. This threshold was seldom met because wetlands are typically of limited extent within the narrow hollows and valleys of most valley fill sites, and also uncommon on steep slopes or ridge crests. On-site mitigation of stream impacts was also not usually practical due to the configuration of valley fills. A stream mitigation threshold was established where the watershed, when measured from the toe of the fill, was greater than or equal to 250 acres and/or when the fill exceeds ½ acre of stream. In West Virginia, most coal companies opted to pay into a stream impact mitigation fund. Impacts were assessed at a rate of $200,000 per acre for permanent stream impacts from the toe of a fill, measured as length times width at the high water mark of Waters of the State. Temporary sedimentation ponds and culverts in stream channels were assessed at a rate of $20,000 per acre for each five-year period of channel occupancy. Coal companies could also perform other local mitigation or improvement projects in lieu of direct cash payment. Mitigation projects were usually developed in coordination with WV Division of Natural Resources.

Virginia Mitigation Prior to 1998

Prior to 1998 Virginia coal mining permits required limited terrestrial and aquatic mitigation for impacts to intermittent and perennial streams as a result of aquatic disturbances such as in-stream ponds or stream diversions/relocations. Much of this mitigation was driven by the In-stream Treatment Agreement between Virginia DMLR and the Environmental Protection Agency. This agreement states that in-stream structures with drainage areas greater than 200 acres will be mitigated. In many cases the operator would opt to leave sediment structures as wetlands to mitigate for stream disturbances. Prior to 1998 the Division of Mined Land Reclamation had no size requirements regarding fills in-stream or fill minimization procedures, however the Division did obtain terrestrial mitigation on the face of many small head of hollow fills.

Virginia did not have a system for payment into a fund in lieu of on the ground work for mitigation in the coal mining region of the state.

Tennessee Mitigation Prior to 1998

The Tennessee Water Quality Control Act including the 1994 amendments required a permit for activities resulting in alterations to the physical, chemical, radiological, biological, or bacteriological properties of any waters of the state.

Prior to 1998 an Aquatic Resource Alteration Permit (ARAP) or 401 certification was required for alterations resulting in alterations to the physical properties of waters of the state. The compensatory mitigation ratio for alterations to wetlands including fill activities was at least 3:1. Fill in waters deemed to be perennial streams was prohibited. Mitigation requirements for ephemeral and intermittent streams were established in the permit conditions of an Individual Aquatic Resource Alteration Permit for activities such as stream relocation. Isolated wetlands equal in size to 0.25 acres, not connected to other waters of the state and deemed non-jurisdictional by the USCOE, and wet weather conveyances were covered under a General ARAP without any compensatory mitigation.

The State of Tennessee has never established any system for which payments to a fund could be made in lieu of groundwork for mitigation. However, the state is currently developing guidelines for establishment of such a fund provided the proposed activity meets certain criteria.

E. COAL MINE DRAINAGE FROM SURFACE MINING

1. Study Area Water Quality Summary

The United States Geological Survey (USGS) has published a series of Open-File reports investigating the hydrology of designated watershed areas (classified by number, called Hydrologic Unit Codes, or HUCs) within the Eastern Coal Province. Many of these watershed areas fall partially or wholly within the study area, but are generally larger watersheds, e.g., 2-10 square miles, and thus may not necessarily represent typical headwater stream water quality. Generally, headwater streams have good water quality (USFWS 2000). The majority of these USGS watershed reports, date from 1981 to 1987 and are currently being updated. Recent reports are available for the Kanawha-New River Basin. These USGS reports characterize the surface water quality and quantity of mined and unmined regions in watershed areas. Watersheds that were assessed include the Little Sandy River and Tygarts Creek in Kentucky; the Clinch, Emory, Obed, Sequatchie, and Tennessee Rivers in Tennessee; the Powell and Clinch Rivers in Virginia; and the Gauley, Elk, Coal, New, Pocatalico, Guyandotte, and Kanawha Rivers as well as Twelvepole Creek in West Virginia.

THE PREDOMINANT SOURCE OF ACID MINE DRAINAGE IS PRE-SMCRA MINING.

The reports indicate that many of the watersheds were affected by coal mining activity, including surface and underground mining, construction and use of ancillary facilities such as roads, coal processing and coal transport. Many mines are located adjacent to or near streams and rivers to permit transport of coal by river barge and railroad. Most coal moves from the mines by rail or truck to a terminal near the larger rivers, and by barge or rail to the final destination. Mines, waste piles, and coal preparation plants, which are located close to streams and rivers, increase the potential for serious water-quality impairment–if improperly treated wastes are discharged. All watersheds appeared to have localized intensified areas of mining that result in moderate to severe degradation of surface water quality. Typically, there were substantial differences in measured values between mined and unmined areas. In areas of mining, decreased pH values and increased values of specific conductance, metals, acidity, sulfate, and dissolved and suspended solids were seen. These USGS reports indicate that localized surface water quality is also compromised by municipal and industrial wastewater discharges and land use changes and development (USGS, OFR 81-803). The 1980 vintage USGS studies may not represent post-SMCRA water quality. The predominant source of acid mine drainage is pre-SMCRA mining. The recent Kanawha-New River Basin studies indicate good surface water quality (Eychaner 1994 and 1998).

Streamflow in unregulated streams typically varies greatly during the year, following the precipitation and evapotranspiration regime. The greatest mean monthly flows usually occur during March, as a result of snowmelt runoff, increased precipitation, and relatively low evapotranspiration. Streamflow during spring and early summer is usually high as a result of increased thunderstorm activity. Streamflow recession during late summer and early fall results from evapotranspiration losses and decline of precipitation activity. During November and December, streamflow usually increases as evapotranspiration decreases and the winter rains begin (USGS, OFR 81-803). Flow duration is affected by many natural basin characteristics such as topography, geology, size of drainage area, climate, and by activities of man, including streamflow regulation and mining.

Surface and underground mines can affect streamflow duration when streamflow is augmented by mine drainage or pumpage (USGS, OFR 81-902).

2. Coal Mine Drainage

Coal mine drainage (CMD) is drainage from surface mining that causes water quality problems. CMD is the characteristic water that is produced from the increased weathering of minerals associated with backfilled material. In undisturbed geologic areas, groundwater flow in rock is typically along zones of secondary permeability, that is, faults, fractures and bedding planes. Minerals associated with the bedrock in the groundwater flow areas have been extensively weathered over millennia. However, during surface mining, the overlying contiguous bedrock that exists over the coal seams, also known as overburden, is broken up into smaller more homogenous rock particles. This break up increases contact of minerals by exposing new minerals to air and water. The exposure results in additional and increased weathering of minerals in the backfilled material.

Sulfide minerals, such as pyrite (FeS_2), are often associated with coal and overburden and are the primary minerals involved in the development of CMD. The oxidation of pyrite leads to the production of acidity and release of sulfate (SO_4^{2-}) and ferrous iron (Fe^{2+}) as indicated in the following reaction (Stumm and Morgan 1996):

$$FeS_{2(s)} + 3.5O_2 + H_2O \Rightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$$

Additional acidity is released from ferrous iron, as indicated in the following oxidation, hydrolysis (the splitting of a compound into fragments by the addition of water, the hydroxyl group being incorporated in one fragment, and the hydrogen atom in the other) and precipitation (the flocculation and settling of materials, in this case, such as iron hydroxides, following their chemical reaction in mine drainage) reaction (Stumm and Morgan 1996):

$$Fe^{2+} + 0.25O_2 + 2.5H_2O \Rightarrow Fe(OH)_3 + 2H^+$$

The above reaction is a simplification, in that the pH, cations (e.g., positive ions such as sodium and potassium) and anions (e.g., sulfate and chloride) affect the precipitation of ferric iron (Fe^{3+}) and precipitate formed, such as, goethite, lepidocrocite and jarosite (Nordstrom 1982). Acidity, soluble ferrous and ferric iron released from pyrite oxidation are capable of reacting with a variety of carbonate minerals (e.g., limestone, dolomite and siderite) and silicate minerals (e.g., clays, mica and feldspar) during neutralization and cation exchange processes (Rose and Crovotta*,* 1998*)*. It is these reactions that can increase concentrations of a variety of common metals (e.g., calcium, magnesium, manganese and aluminum) and trace metals (e.g., copper, cadmium, nickel and zinc). The resulting CMD will vary widely in composition, depending on the characteristics of the backfilled material and reclamation practices. There are generally two categories of CMD: acidic mine drainage (AMD) and neutral/alkaline mine drainage (NAMD) (Rose and Crovotta*,* 1998). Both types reflect, to some degree, oxidation of sulfide minerals and the release of acidity, iron and sulfate.

AMD is the category of mine drainage in which mineral acidity exceeds alkalinity. In many cases there is <u>no</u> alkalinity present. The pH of AMD varies widely from 2 to 6, and acidity ranges from

0 to 1000s of mg/L (measured by standard practice in terms of $CaCO_3$ equivalency, or the amount of calcium carbonate per unit volume that it would take to neutralize the acid sample). The high acidity is a result of elevated concentrations of dissolved metals--primarily iron, aluminum and manganese. These metals can be hydrolyzed and release additional acidity. In addition to hydrolyzable metals, AMD contains a variety of anions (negative ions, in this case primarily sulfate) and cations (such as, calcium and magnesium) that are the result of the pyrite oxidation, neutralization reactions and cation exchange in the overburden. Sulfate levels will range from 50 to 1000s mg/L depending on the amount of sulfide minerals and oxidation rates in the backfilled material.

NAMD is the category containing alkalinity equal-to-or-greater than mineral acidity. Since pH is circumneutral, that is approximately 7, mineral acidity is associated with dissolved ferrous iron and manganese only. Aluminum solubility is very low, less than 0.5 mg/L, at circumneutral pH. Dissolved metals and sulfate vary considerably in NAMD, depending on whether sulfide mineral oxidation occurs prior to or after groundwater has contact with an alkaline material, such as limestone. Sulfate and dissolved metals are typically lower in mine drainage where alkalinity is present before contacting sulfide minerals, due to lower oxidation rates that occur at an elevated pH. Greater dissolved metals and sulfate result in NAMD where neutralization and alkalinity is added after sulfide minerals are oxidized, a result of accentuated mineral sulfide rates at lower pH (Moses 1987). This difference is important. There is a greater potential for trace metals and metalloids to be contained in the NAMD, formed as a result of the later process, due to increased weathering and greater solubility.

a. Indicator Parameters

As previously discussed, mining activities tend to increase weathering of rocks and, as a result, increase the amount of dissolved minerals in the contact water and in watersheds containing mining activity. A number of other anthropogenic land uses, such as, agriculture, silviculture and urbanization, are also known to increase dissolved minerals in surface waters. Two parameters, specific conductance and total dissolved solids (TDS), are used to estimate the amount of dissolved minerals in mine drainage, other contaminated and natural waters. Specific conductance is a measure of the ability of water to carry an electrical current (as measured using a current cell and meter detecting the current returned) and is proportional with the quantity of ionized minerals in solution. Specific conductance rises with increasing dissolved minerals. TDS is measured by drying the matter (suspended solids) remaining after water is passed through a filter (APHA 1989). The two parameters can generally be correlated with specific conductance typically representing about 1.1 and 1.9 times TDS in most waters. Unfortunately, sample handling and methodology can often alter TDS and specific conductivity results, which may affect direct comparison of the two parameters. There is no accepted natural range for either parameter in “uncontaminated” water, due to their dependence on surrounding geology and land use. However, natural or unpolluted freshwater generally have specific conductance between 20 and 500 micromhos (µmhos) and TDS between 10 and 250 milligrams per liter (mg/L). As reported in Rose and Crovotta (1998), CMD has been reported to have specific conductance in excess of 5,000 µmhos (TDS of 3,000 mg/L).

A common parameter used to assess water quality and evaluate impacts of mine drainage is pH (the measure of the hydrogen ion activity $\{H^+\}$ in water) and is typically estimated using an electrode and meter calibrated with known pH buffer solutions (APHA 1989). The pH scale is 0 to 14, but pH of natural or unpolluted waters generally fall between 5 and 10. Typical convention is to consider a water with a pH of 7 as neutral, values less than 7 as acidic, and greater than 7 as alkaline. This convention may lead to confusion in evaluating impacts of mining, since waters with pH in the 5 to 7 range may occur naturally and have alkalinity present in excess of mineral acidity (parameters discussed below). It may be more appropriate to consider pH as an indicator of aquatic health-- with optimal pH for aquatic life falling between 6 and 9. This pH range is also the range of minimal solubility for most toxic metals (e.g., aluminum, copper and zinc) that may be present in water (Stumm and Morgan 1996); the exception would be reduced metal species such as ferrous iron, which are unstable under oxidizing conditions. Values of pH outside this range (less than this range in the case of mining), would be suggestive of coal mine discharge-related impacts if and only if, other indicator parameters are also present. For example, acid rain-impacted surface waters may also have lowered pH (Herlihy *et al.* 1991).

Alkalinity, usually reported as milligrams per liter (mg/l) of $CaCO_3$, is an aggregate property of water that reflects its ability to neutralize acid inputs and in natural waters is typically a measure of the bicarbonate ion (HCO_3^-). In combination with acidity (carbonate system only), the two parameters assess the ability of a water to resist pH change, which is commonly referred to as "buffering capacity." Alkalinity is measured by titrating a sample (adding a solution, with an eye dropper-like device called a pipette, drop-by-drop) with a known acid concentration to a pH endpoint between 4 and 4.5. This endpoint is known by a color change of the titrated water with a pH sensitive dye called bromocresol green, or is measured with a pH meter (APHA 1989). Natural or unpolluted waters will range from near zero buffering capacity, for smaller headwater streams and poorly buffered waters, to more than several hundred milligrams per liter buffering capacity, for larger waters and waters in predominately limestone regions. Coal mining can cause alkalinity to increase or decrease, in the receiving stream, depending on overburden characteristics and mining and reclamation practices.

Acidity in natural or unpolluted waters (usually reported as milligrams per liter (mg/l) of $CaCO_3$), is another aggregate property of water that reflects its ability to neutralize base inputs and in natural waters, is typically a measure of the presence of carbonic acid (H_2CO_3) and bicarbonate ion (HCO_3^-). In conjunction with alkalinity, these two parameters represent the buffering capacity. Carbonate acidity is titrated with a known concentration of base solution to a pH endpoint of 8.3, as determined colorimetrically with metacresol purple or with a pH electrode and meter (APHA 1989). Acidity in CMD can be difficult to evaluate, because of the potential presence of reduced forms of primarily two metals, iron and manganese, which may or may not be included in the standard acidity titration method. In evaluating mine related acidity, it is frequently necessary to measure a different type of acidity, known as hot mineral acidity, which will include the contribution of reduced forms of metals on acidity. This method uses acid to lower the pH. and remove carbonate-related acidity, hydrogen peroxide as an oxidant, and heating to increase the rate of oxidation prior to titrating to the pH 8.3 endpoint (APHA 1989). This hot mineral acidity is also an aggregate parameter of the potential of a water to depress pH from the release of hydrogen ions during the hydrolysis and precipitation of soluble metals. Difficulty arises in evaluating hot mineral acidity results due to reporting differences in coal mining-related studies (frequently reported as acidity, total acidity, mineral acidity and total mineral acidity) and as negative or zero values where alkalinity exceeds hot mineral acidity. Hot mineral acidity reported from a number of coal mined sites (abandoned and permitted) ranged from zero to several thousand milligrams per liter (Rose and Crovotta, 1998).

Sulfate is a good indicator of influence by CMD, because its presence in coal mined areas is generally indicative of sulfide mineral oxidation. Natural or unpolluted freshwater can have elevated sulfate levels in the five to twenty milligram per liter range, depending on the influence of acidic deposition and connate water. In addition, sulfate can be increased from a variety of anthropogenic sources, including treated and untreated wastewater, urban and residential runoff, and agricultural practices. Common methods for analytical sulfate concentration determination include ion chromatography and turbidimetric methods (APHA 1989). Elevated levels of sulfate in CMD can exceed several thousand milligrams per liter and, as a result, can be increased in receiving surface waters to appreciable levels, depending on the CMD source and extent of mining throughout the watershed.

The most common metal used to evaluate impacts of coal mining on surface waters is soluble or total iron, which is contained in CMD, as a result of, sulfide mineral oxidation; iron may also be present from the solubilization of siderite. In most natural or unpolluted surface waters, soluble iron is either near or less than quantifiable concentrations due to its relative insoluble properties in oxidizing and circumneutral water environments. Soluble iron can be found in unpolluted surface waters, such as lake hypolimnion (bottom waters) and groundwater where low dissolved oxygen levels persist. The impact of soluble iron on water quality is generally related to drinking water aesthetics, taste and odor. However, at high concentrations, exceeding 1 mg/L, iron oxidization and precipitation in surface waters can impact stream and lake bottoms due to the formation of "yellow boy" precipitates or staining, named for its yellowish-red appearance, which destroys habitat for aquatic insects and spawning fishes (Hoehn and Sizemore 1977). Iron concentrations are determined colorimetrically or by atomic absorption spectrometry (APHA 1989) and for CMD can range from less than one to values greater than several hundred milligrams per liter.

In addition to iron, manganese is frequently evaluated as an indicator parameter of CMD impacts on surface and groundwater. Its presence is usually considered a result of secondary weathering of carbonate minerals (Crovotta *et al.* 1994). In most natural or unpolluted surface waters, soluble manganese is absent due to its limited solubility in oxidizing and circumneutral water environments similar to iron. If present, manganese may persist in surface waters longer than iron, due to much slower oxidation rates. The effects of manganese are generally related to drinking water aesthetics, taste and odor. EPA established CMD discharge limits for manganese based on links of its presence to toxic metals (e.g., copper, cadmium and nickel) in AMD. Recent studies indicate that other parameters, such as zinc or hot mineral acidity, may be better indicators of the presence of trace metals (Unz and Royer 1997). Manganese precipitation in surface waters may cause similar impacts as "yellow boy" and higher concentrations of manganese (concentrations in excess of 20 mg/l) may be toxic to early life stages of fishes (Lewis 1976, England 1977, Lewis 1978).

Aluminum is another metal frequently found in AMD, but is typically not found in NAMD. Its present is a direct result of secondary weathering of silicate minerals (e.g., clays). The presence or absence of aluminum is a direct result of pH-dependent solubility, with aluminum solubility increasing from, much less than 1 mg/L at circumneutral pH, to greater than 100 mg/l at pH less than 3 (Stumm and Morgan 1996). In soluble form, aluminum is hydrolyzable. In this form, it can be one of the major total "hot" acidity components in AMD, but is of little importance in NAMD or AMD, where the pH is greater than 5. Aluminum, when present in soluble form, is toxic to aquatic life at concentrations as low as 0.1 mg/l (Gagen *et al* 1994), but its pH-dependent solubility limits the toxic conditions to water of pH typically less than 5.5; water of pH greater than 9 may also contain appreciable soluble aluminum. As an indicator, aluminum would only be of value in low pH waters where other parameters would be present at levels to provide sufficient evidence of mine drainage influence. In addition, since aluminum is one of the most common elements in the earth's crust, its presence, when measured as total aluminum, may be related to suspended solids contained in the sample from various sources, including eroded sediment carried in high flow runoff events and sediments entrained during sample collection.

Total suspended solids (TSS), the measure of particulate material suspended in a sample, is frequently included in parameters used to assess CMD-related impacts. TSS is measured gravimetrically, by weighing the amount of solids captured on a filter (APHA 1989). TSS can be a useful parameter to evaluate entrainment of sediment into a sample and erroneous iron and manganese measurements, which are frequently measured as total (requiring acid digestion) concentrations. In addition, TSS in waters is an indicator of upstream erosion, which may be the result of earth disturbances such as surface mining. TSS may also be increased in surface waters from other anthropogenic activities related to agriculture, silviculture and urbanization. Changes and differences in TSS concentrations associated with surface mining are also difficult to identify and assess, because TSS typically only occurs during storm-related runoff events, and is dependent on rainfall intensity, duration and antecedent conditions.

b. Effects of Coal Mine Drainage

Coal mine drainage can have a significant environmental impact, particularly on pre-SMCRA mine sites where prevention controls were not required. Once AMD occurs, it is a long-term problem. This section provides a summary of environmental impacts of CMD in surface coal mining operations.

CMD can cause chemical toxicity to aquatic life. Most aquatic organisms have specific pH tolerance ranges within which they can survive, and changes in pH resulting from CMD may result in poor health or mortality. An example would be fish kills that occur when large precipitation events flush acidic water from abandoned deep mines into streams. Fish usually cannot survive in streams with a pH of 4.5 or less (Doyle, 1976). Similarly, at reduced pH, aluminum and manganese can reach lethal levels, as well as combinations of mineral acids and iron and sulfur ions (Gore 1985). In severely impacted streams, CMD chemical toxicity may eliminate all aquatic life.

CMD may produce physical and chemical impacts to streams as a result of chemical precipitation. As CMD discharges co-mingle with cleaner surface waters, acidity is reduced, and entrained metals and sulfate become increasingly unstable in solution. Iron and aluminum will tend to precipitate as hydroxides forming orange and white (yellow boy) sludge that coats stream bottoms. If calcium is present in solution and the pH is sufficiently elevated, gypsum ($CaSO_4$) will also precipitate. These sludge materials have the effect of smothering the stream bottom, inhibiting the feeding and reproduction of benthic macroinvertebrates (worms, nymphs, crustaceans, etc.) and destroying fish spawing habitat.

CMD can adversely affect human populations by impuring surface and ground water used for drinking water and recreational purposes. Public and private water supplies drawing from CMD-affected sources may require additional treatment processes to produce potable water, which can add significantly to the cost of the water supply. Loss of aquatic life in a water body reduces the recreation values, with attendant economic losses to the surrounding community. In terms of aesthetics, CMD can have a significant visual impact in affected streams resulting from the unnatural appearance of the iron sludge coating. Acidic waters can also affect physical structures, increasing corrosion of steel and concrete bridges, culverts, and other in-stream structures, reducing their functional lives. OSM compiled preliminary records on post-SMCRA mine sites that have CMD problems (OSM, 2000). These include sites still active and sites where bond forfeiture occurred, as shown in Table III.E-1. Several of these sites may be in Western Kentucky and Northern West Virginia outside of the EIS study area, and as many as a third of the sites may be underground mine sites. However the information does provide a general indication of the scope and significance of CMD.

Table III.E-1 Estimates of Post-SMCRA CMD Sites for States in the Study Area

State	Active Mine Sites		Bond Forfeiture Sites	
	# Permits	# Discharges	# Permits	#Discharges
Kentucky	10	10	27	30
Tennessee	13	34	2	3
Virginia	24	26	6	6
West Virginia	363	635	119	286
Total	410	705	154	325

Table III.E-2 shows the estimated amount of CMD from the four states in the EIS study area, as well as the types of estimated “loadings” (e.g., chemical constituents per unit volume of flow) for several indicator parameters. The data presented under the average column headings are averages per site. The data presented under the total column headings are totals per state.

Table III. E-2 CMD Flow and Loading Estimates for Post-SMCRA Mine Sites in Study Area States

State	**Total Flow (gpm)**	**Average Acidity (mg/L)**	**Total Acid Load (lbs./day)**	**Average Alkalinity (mg/L)**	**Average Fe (mg/L)**	**Average Mn (mg/L)**	**Average Al (mg/L)**
Kentucky	1,094	341	5,534	45	78	6	16
Tennessee	1,908	110	1,892	76	51	16	1
Virginia	3,508	81	232	81	6	4	10
West Virginia	59,993	299	111,158	43	41	16	20
Total	66,503	208	118,816	61	44	11	12

3. Methods of Controlling CMD

Once established, CMD is typically a long-term problem that is technologically or economically difficult to correct. Avoidance of CMD is a provision of the hydrologic balance protection standard in SMCRA, and regulatory agencies are authorized to restrict mining if there is a risk of CMD formation. Mining in potentially toxic areas is not precluded, but the mining applicant must demonstrate that CMD formation can be avoided by mining and reclamation practices (OSM 1994). In the event of CMD formation, the permit holder becomes liable for treatment of the CMD discharge to meet CWA receiving stream standards until such time as the situation is corrected, which can represent a considerable expense for long-term treatment obligations.

The simplest form of CMD prevention is avoidance of coal or overburden containing excessive amounts of pyritic material. The permitting process for a mine site normally requires collection of overburden and coal samples to be analyzed for pyritic content (usually expressed as total sulfur content) and neutralizing potential or alkalinity (usually expressed as tons of calcium carbonate equivalent per thousand tons of material). If the acidity generation potential of the pyritic material exceeds the neutralization potential of the overburden and coal, the area represented by the samples is considered to have potential to cause CMD if mined. If the acidity generation potential greatly exceeds the neutralization potential, the site may be considered of too great a risk to mine by either the coal operator or the reviewing regulatory agency. For low- to moderately-acidic sites, various practices may be employed to reduce the risk of CMD generation, as discussed in the following section.

The annual costs for Kentucky, Tennessee, West Virginia, and Virginia sites treating CMD are estimated to exceed $37,000,000 for active mine sites and $5,600,000 for forfeiture sites. The cost to construct treatment systems at sites where discharges are untreated in the four states is estimated at $3.8 million for active sites and $3.1 million at forfeiture sites. Thus, the impact is not only environmental, but economic as well. The high, long-term cost of CMD treatment serves as a strong incentive for mining companies to avoid coal seams and overburden in known CMD-producing areas. Where avoidance does not occur, companies take special care in development of mining plans with special handling controls to prevent or minimize CMD development (see next sections). Both

SMCRA and CWA are designed to minimize CMD problems through proper planning and handling, but if all else fails, long-term treatment will be required to assure minimal impacts to the hydrologic resources.

a. Overburden Blending

If potentially toxic pyritic materials are scattered or contained in stratigraphic units that cannot be readily identified and segregated during mining, and the overburden is found to be net alkaline on a whole for a given mining area, most mining operations will use overburden blending to avoid CMD formation. This concept assumes that excavation and backfilling processes will sufficiently mix the toxic materials with other non-toxic or alkaline overburden materials to form a relatively homogeneous, "net alkaline" spoil. Alkaline materials may also be redistributed within a mine site from areas of excess alkalinity to areas of alkaline deficiency. This method is generally the most common in use for MTM/VF mining sites.

b. Isolation Methods

The concept behind isolation of potentially toxic overburden is to prevent contact between pyritic material and oxygen and water, thereby excluding both reactants necessary to form CMD. Isolation requires selective collection and placement of toxic materials during mining (a process known as *special handling)*. Toxic materials are typically segregated during mining and placed in backfill "pods," which are elevated above the anticipated postmining groundwater level and may be encapsulated by non-toxic materials to further inhibit contact with oxygen (Perry et. al. 1998). This adds to the cost of the mining process, because of the additional material handling steps and the necessity, in some cases, to create additional mine benches on toxic overburden horizons that would not be needed to recover coal seams alone. Isolation is another commonly-proposed method of CMD avoidance in MTM/VF mining.

c. Submergence Methods

Submergence of toxic overburden materials is a form of isolation, in that oxygen is expected to be excluded from contact with pyritic materials by permanent submergence under water. This requires a relatively flat isolation area with a deep, permanent, and essentially stagnant postmining water table to prevent migration of oxygen into the containment area. This method is not widely used in the Appalachian mining region (Perry et. al. 1998).

d. Alkaline Addition

A direct approach to correcting a net deficiency in overburden alkalinity is to add alkaline material during the backfilling process to serve as a neutralizing agent. This method has been applied on a number of mine sites with varying degrees of success. Crushed limestone, kiln dust, or alkaline fly ash materials are typically used as neutralizing agents, and may be placed on the pit floor prior to backfilling, mixed with spoil during backfilling, or applied to the reclamation surface during regrading. A combination of pit floor spreading and backfill blending appears to be the most effective. The most successful alkaline addition sites are those that have used substantial addition rates (500 tons per acre or more) or those with low cover overburden and very low concentrations of pyritic materials (Smith & Brady 1998). This practice requires a ready source of alkaline addition materials--either on the mine site, or within an economical haulage distance. Because of the scale of MTM/VF mining operations, alkaline addition could represent a considerable expense for mining; and blending or isolation methods are preferred.

4. Abandoned Mine Lands

Abandoned mine lands (AMLs) are pre-SMCRA (i.e., mining occurred before 8/3/77) sites where mine operators were not necessarily required to conduct various backfilling, regrading, or revegetation techniques and where SMCRA reclamation bonds were not applied. These lands are widespread within the study area coalfields, visible as unreclaimed spoil piles, open highwalls, coal refuse piles, and abandoned mine facilities. AMLs can represent a considerable reclamation liability to the public, as pre-SMCRA mine operators are not normally under a legal obligation to reclaim them. AMLs are a primary source of AMD discharges, often representing physical hazards due to unreclaimed highwalls and unstable slopes, and are visually unattractive and are generally low productivity lands.

Under SMCRA, the OSM was authorized to oversee the implementation of and provide funding for state AML reclamation programs. Funding was established by a tax on mined coal, and AML funds are redistributed to the states based on their primacy status and the priority listing of their abandoned sites for reclamation. Kentucky, Virginia, and West Virginia administer their own AML programs, while Tennessee's AML Program is administered directly by OSM, although in cooperation with a State agency. Although these AML programs have been successful to date in remedying most "high" priority AMLs, many "low" priority sites still await funding for reclamation. The "high" priority sites are to correct safety hazards. Environmental remediation is not in the highest priority category; therefore, the ability for AML funds to correct environmental problems is extremely limited. Recent collaboration led by OSM with EPA, COE, and other agencies created the Appalachian Clean Streams Initiative (ACSI) that is addressing pre-SMCRA CMD problems through construction of passive treatment and other remedial approaches. While AML funding through ACSI has steadily increased, many mining program experts believe it will not be possible to effectively remediate aquatic resources damaged by past mining through the AML program.

5. Remining

A coal remining operation is defined by CWA Section 301(p) as "...a coal mining operation which begins after February 4, 1987 at a site on which coal mining was conducted before August 3, 1977," and a remined area is "...only that area of any coal remining operation on which coal mining was conducted before August 3, 1977." In essence, remining is new coal mining undertaken in areas of pre-SMCRA mining activities, including AMLs. The term is considered separate from new mining conducted on sites mined after August 3, 1977 because of certain water quality liability relief measures afforded by CWA Section 301(p) for potentially beneficial reclamation activities on pre-SMCRA sites.

Remining represents an avenue for achieving low- or no-cost reclamation of AMLs, with private mine operators affecting the reclamation as part of their normal mining operations on a site. Remining normally occurs where unmined coal reserves on pre-SMCRA sites have become economical to mine because of advances in equipment capabilities and mining methods. MTM/VF operations, for example, can completely recover high-cover (a large ratio of overburden to coal volume) coal seams that could have only been economically and partially-mined from the outcrop by operations occurring decades ago. Remining operations generally must meet the same reclamation standards as other surface coal operations, and leave remined areas reclaimed to modern standards on completion. Exceptions from meeting the standards for water quality are relaxed where remining occurs in areas with pre-existing CMDs. Highwall elimination, topsoil salvage, and revegetative success standards also are adapted to remining situations.

a. Water Quality Benefits of Remining

Adverse water quality conditions on AMLs are often related to the mining technique that was employed on the sites. Pre-SMCRA surface mines often did not employ backfill regrading or special handling techniques for acid- and toxic-forming overburden, leaving spoil cast in loose, irregular piles and open mine pits where water could pool in contact with acidic pit floor materials. Pre-SMCRA underground mines also were not designed for AMD prevention and underground mine pools formed in flooding mines after abandonment, exposing to acidic materials in remaining coal to water and oxygen from open mine entries.

On surface mine sites, remining may ameliorate existing AMD conditions by regrading and revegetating the unreclaimed spoil surfaces to restore a more natural surface runoff pattern and limit the infiltration of atmospheric oxygen into the spoil. Backfilling and regrading of highwalls eliminates open pit floor pools and reduces the exposure of groundwater on the pit floor to oxygen following backfilling. Remining may extend to greater cover depths than historic operations and potentially liberate greater amounts of alkaline material, which tends to naturally weather out under low cover. Revegetation also reduces sediment runoff from sparsely vegetated or unvegetated spoil piles and pit floors. Hydrologic routing during mining and reclamation also controls the points at which infiltration and contact with CMD-forming spoil can occur.

On some sites, it is economical to mine former underground mine workings, depending on the depth of the seam and the quantity of the coal remaining. This process is known as *daylighting*, whereby some or all of an underground mine is excavated, and the void is backfilled with spoil once the coal has been recovered. This can be very beneficial to water quality, since groundwater pooling in mine voids is in contact with potentially acidic material remaining in the coal, roof, and floor materials. Ongoing collapse of mine voids tends to rejuvenate the exposure of pyritic materials over time, continuing the process of AMD formation for long periods. After surface mining and reclamation, no voids remain in the remined areas, and the pyritic material in the coal and mine roof is replaced with more homogeneous spoil, potentially with neutralizing alkaline material (if present in the overburden). Remining can also redirect groundwater movement patterns by eliminating preferential drainage paths along structural gradients in mine voids, potentially reducing the quantity of water draining to any remaining underground mine workings.

A study conducted in the Pennsylvania bituminous coalfields indicates that the majority of remining operations resulted in either no change or an improvement in water quality in terms of contaminant loading (Hawkins 1994). Loading is the mass of a contaminant carried by water, as opposed to its concentration, and is a better measure of the potential impact of a discharge on downstream water quality. Of 24 sites studied, 8 showed significant reductions in AMD contaminant loadings, as opposed to 4 that showed significant increases, with the remaining 12 sites showing no significant change in water quality. The study notes that significant increases in water quality were usually associated with operations that daylighted substantial areas of abandoned underground mines. It is also suggested that water quality improvements may not be immediately apparent following remining due to the time necessary to equilibrate the site, and that several years of observation may be necessary to assess any long-term benefits.

b. Regulatory Aspects of Remining

One deterrent to remining by private mine operators is the presence of pre-existing AMD on previously mined sites. Under normal circumstances, the mine operator would assume responsibility for non-compliant discharges emanating from a permitted mine site. To promote remining reclamation, CWA Section 301(p) provides for federal or state mine permitting programs to allow special provisions concerning pre-existing discharges on remining sites. Briefly, applicable permitting programs may modify effluent limitations on a case-by-case basis for pH, iron, and manganese where pre-existing discharges will be affected by remining operations. Adjustments to effluent standards are made using best available technology and best professional judgement to set site-specific numeric effluent limitations. The permit applicant must demonstrate that the remining operation will result in potential water quality improvements. The applicant must also not allow pH levels to drop or iron and manganese levels to rise (above levels before remining) or exceed state water quality standards. The Interstate Mining Compact Commission (IMCC), a network of coal mining regulatory programs formed by the governors of numerous coal mining states) has a remining task force. Kentucky, Virginia, Tennessee, and West Virginia have active remining programs to promote remining. The Energy Policy Act of 1992 (modifying SMCRA) has remining provisions.

Kentucky

The Kentucky Department for Surface Mining Reclamation and Enforcement (DSMRE) strongly supports and has been encouraging remining activities for several years. Remining benefits both the people and the environment of Kentucky through reclamation of abandoned mine lands at little or no cost to the government. Kentucky Reclamation Advisory Memorandum 129 (RAM #129) discusses certain issues and procedural matters related to remining operations and implementation of the incentives. RAM #129 includes relevant definitions and explains eligibility, permitting, and bonding related to remining.

Permittees may enter into an agreement with DSMRE for reclamation of AML-eligible sites adjacent to coal mining permit areas. However, DSMRE is not obligated to enter into any Reclamation Agreement. Criteria, as listed in RAM #129, must be demonstrated for DSMRE to consider an AML Reclamation Agreement with a permittee.

RAM #129 criteria include:

- The proposed reclamation area must have been determined to be AML-eligible by the DSMRE's Division of Abandoned Mine Lands (DAML). The eligible reclamation site will be inventoried by the DAML and registered on the national Abandoned Mine Land Inventory System (AMLIS).
- The proposed area must be identified by the DAML as priority III, or greater, in accordance with KRS 350.555 and Section 403(a) of the Federal Surface Mining

Control and Reclamation Act of 1977.

- The proposed area must be causing off-site environmental impacts, but with little likelihood that the site could be addressed under the AML program in the foreseeable future.

Virginia

Virginia has an active Clean Water Act section 301 program. Virginia is actively working with the EPA in pursuing a regulation change to the Clean Water Act for the coal remining category for discharges from remining sites. Seventy percent to eighty percent of Virginia surface mining permits include at least some AML areas, according to a ongoing Virginia DMME study. Anecdotal information indicates that this percentage is on the increase, as very few first-cut surface mining operations are currently active in Virginia.

Virginia's experience documents the significant environmental benefits of remining on AML properties. Individual operations have eliminated eroding outslope areas, daylighted acid-producing AML deep mines to produce improvements in water quality, and backfilled dangerous highwall areas with excess spoil from active mines. One severe AMD/AML site, eligible for ACSI funds, has been substantially reclaimed via a remining operation and water quality has been improved dramatically–without expenditure of AML Trust Fund dollars.

Coal mine operators will not seek to permit most AML areas for fear of incurring liabilities that they will not be released from. These areas include barren and eroding outslopes, unstable highwalls, AMD seeps, open pits, and underground mine portal openings. To encourage remining of the AML areas, Virginia DMME has been providing incentives for AML reclamation by active mining operations. Several of the incentives are being formalized through rule changes proposals filed with OSM for program amendment approval. These program changes would result in increased AML reclamation via remining. For example, the “no-cost AML contract” allows active operators to backfill AML highwalls, cover acid-forming material, and to stabilize outslopes; improving environmental conditions and reducing or eliminating spoil placement in hollow fills.

The Virginia coal industry is on the decline. Coal production has fallen from 38 million tons in 1997 to 32 million tons in 1999. Without these mining operations, the opportunity to reclaim these AML sites would be lost. Once an operator mines through an area, the remaining coal reserves are depleted.

West Virginia

Remining operations are addressed by Module 13 of the WVDEP surface mine permit application. Applicants must provide an abatement plan discussing the alternatives considered, and detailing why the selected remining plan will result in water quality improvements. Applicants are required to collect consecutive bi-monthly samples for one year (24 samples minimum) from pre-existing discharges in areas to be affected by remining, and from upstream and downstream sample points on receiving streams for these discharges. Acidity, iron, and manganese effluent limitations are based on loading rather than concentration.

Daily maximum effluent limits are established for each discharge by using the third greatest concentration observed in the entire baseline monitoring data set for each parameter. Monthly average limitations are established separately for the summer/fall (May to October) and winter/spring (November to April) seasons. These are set as the average of the two median values from the data sets for each season. A trend line monitoring limit is established, setting a threshold limit, beyond which, revisions to the abatement plan may be necessary. This applies only to acidity. The trend line limit is set as the average daily loading of all baseline data for the pre-existing discharges contributing to a given watershed outlet.

A bond release limit is also established to determine the maximum annual loading that the remining area can contribute to receiving streams and still retain bond release. This is calculated as the cumulative annual average loadings for acidity, iron, and manganese. The averages are based upon baseline monitoring data on pre-existing discharges affected by the proposed remining operation.

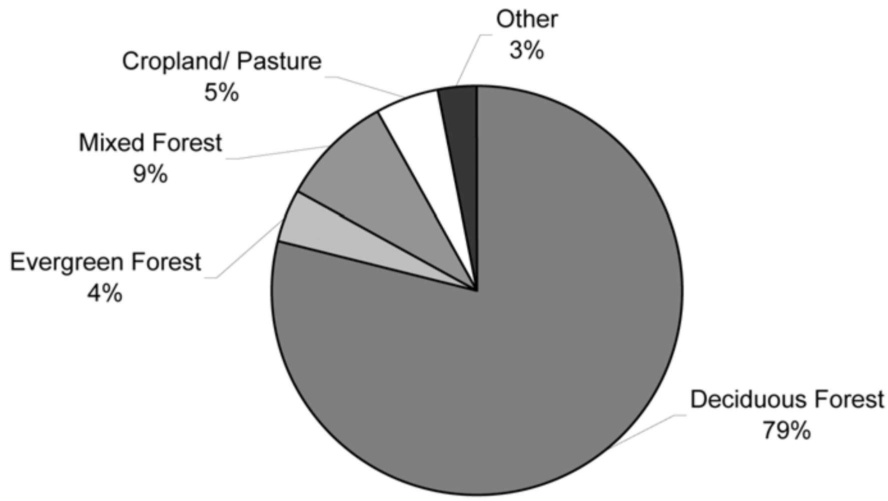
The final component of the West Virginia remining permitting process is establishment of in-stream water quality permitting conditions and in-stream water quality standards. The applicant provides minimum, average, and maximum values for pH, iron, and manganese for downstream baseline data on receiving streams. The applicant then provides in-stream water quality standards felt to be necessary to achieve bond release for the remining area, along with explanation of the methodology used to arrive at these standards. The desired standards are then used to apply for a water quality variance from the Environmental Quality Board.

Anecdotal information from the WVDEP indicates that few mine operators have opted for the remining designation to date. This is due to an earlier program that offered remining protection, but was later revoked, leaving some operators with unexpected liabilities.

F. APPALACHIAN FOREST COMMUNITIES

The study area contains many different terrestrial habitats resulting in a wide diversity of wildlife species including both game and nongame species. This diversity is due, in part, to the fact that the study area is geographically positioned between northern and southern vegetative communities, and that it has a complex and variable topography. The majority (92%) of the study area is forest land [Figure III.F-1 - Anderson Level Land Use/Cover in the Project Study Area].

Figure III.F-1 - Anderson Level Land Use/Cover in the Project Study Area



Characteristic vegetation types are found within each previously described ecological subregion section [Refer to Table III.A-1 - Ecological Subregion Section Characteristics]. The mixed mesophytic forest type is common throughout the project area. Mixed mesophytic forests are those found in habitats of intermediate moisture regime (between wet and dry). Likewise, oak dominated forest types are characteristic of each ecoregion and often co-occur with various pines. Pine dominated forest types are less common and are virtually absent from the study area. Other forest types common to these ecoregions, but not necessarily associated with the project study area, include the spruce-fir, northern evergreen, and floodplain communities (Straughsbaugh and Core, 1997; Martin et al., 1993).

Slope and aspect describe the angle and facing direction, respectively, of a mountainside. Slope and aspect have strong influences on soil moisture and thus, strong effects on vegetative communities. In the Appalachians, forest communities are distributed along both elevation and moisture gradients (Whittaker, 1956). Cove forests tend to dominate the steep-sided, mesic, (relatively moist) canyons while pine-heath communities dominate the more xeric (dry) ridges and peaks. Various oak forests dominate the flats and more open slopes that are intermediate between mesic and xeric conditions.

General forest types can be subdivided into more specific types. Ten different forest cover types are depicted in the West Virginia Gap Landcover for the West Virginia portion of the study area. Both the National Landcover forest cover types and the West Virginia Gap Landcover equivalents are presented in Table III.F.-1.

**Table III.F-1.
Areas of Different Forest Cover Types
in the West Virginia Portion of the Study Area**

National Landcover Dataset Forest Cover Type	Area (acres)	WV GAP Dataset Forest Cover Type	Area (acres)
Deciduous and Woody Wetlands	2,398,222	Diverse Mesophytic Hardwoods	1,852,790
		Cove Hardwoods	350,862
		Mountain Hardwoods	258,679
		Oak Dominant	193,833
		Floodplain	17,383
		Woodlands	5,716
		Total	**2,673,547**
Evergreen	52,910	Mountain Conifer	865
		Conifer Plantations	168
		Total	**1,033**
Mixed	252,520	Hardwood/Conifer	31,634
		Mountain Hardwood/Conifer	793
		Total	**32,427**
All Forest Cover Types	**2,703,652**	**All Forest Cover Types**	**2,712,723**
Total WV Study Area	**2,896,833**	**Total WV Study Area**	**3,007,623**

Note: The difference in total forest cover acres between the two data sets are a matter of scale.

The following text describes the forested communities of the study area. To avoid confusion with nomenclature related to author preference, we have listed the community types as presented by Martin et al. (1993) and placed in parentheses the forest community name used by the National Landcover Dataset and the West Virginia Gap Dataset.

1. Broadleaf Deciduous Forest Communities

a. Mixed Mesophytic Forests (Diverse Mesophytic Hardwood Forests)

Mixed mesophytic forests are found in moister habitats of north-facing slopes and in coves. The mixed mesophytic forest of the Appalachian coal fields supports one of the richest floral, breeding bird, mammal, and amphibian communities of any upland eastern U.S. forest type (Hinkle et al., 1989; cited in McComb et al., 1991); it has also been described as "the most biologically diverse ecosystem in the southeastern United States" (Hinkle et al., 1993). The diverse mesophytic forest is the dominant forest type in the study area, comprising slightly more than 68% of the forested portion of the study area in West Virginia.

Canopy species common to the mixed mesophytic forest type include American beech (*Fagus grandifolia*), yellow poplar (*Liriodendron tulipifera*), white basswood (*Tilia heterophylla*), various maples (*Acer* spp.), various oaks (*Quercus* spp.), as well as other species. The understory is usually diverse with more than 25 understory species known throughout the study area. Ferns and spring herbs are also abundant in the mixed mesophytic forest type. Among these are fragile fern (*Cystopteris fragilis*), jack-in-the-pulpit (*Arisaema triphyllum*), wild ginger (*Asarum canadense*), and many others (Strausbaugh and Core, 1997).

Due to the abundance and variety of fruits, seeds, and nuts, mixed mesophytic forests provide excellent habitat for wildlife and game species alike. Also, an important forage source for migrant birds, especially in the spring, are invertebrates of the mesophytic forest (e.g., caterpillars, spiders, soil invertebrates). Species of birds typically present include the wood thrush (*Hylocichla mustelina*) and acadian flycatcher (*Empidonax virescens*). Additionally, many invertebrates are unique to the cove hardwoods habitat. For instance, the Diana fritillary butterfly, (*Speyeria diana*) is a denizen of the mixed mesophytic forests of southern West Virginia south to northern Georgia (Allen, 1997).

Under certain climatic and soil conditions, such as those found at the middle of north-facing slopes, eastern hemlock (*Tsuga canadensis*) or white pine (*Pinus strobus*) can become very prominent within the mixed mesophytic forest type. Although these trees provide cover for wildlife, their shade prevents the development of the understory vegetation that serves as food for game species. However, these tress do provide important habitat for various birds and small mammals. Blackburnian warblers (*Dendroica fusca*) and black-throated green warblers (*D. virens*) may inhabit areas that contain eastern hemlock and white pine.

Cove hardwoods, a subset of the mixed mesophytic forest type, are found in cool, moist valley bottoms and on lower slopes (Wilson et al., 1951, Hinkle et al., 1993). Because of their position on lower slopes, cove hardwoods form the upland forest border of the agricultural bottomlands that are scattered throughout the central section of the Appalachian Basin. The many layers of vegetation and the lush ground cover make the cove hardwoods an important habitat type for wildlife (USFWS, 1978). Cove hardwoods comprise approximately 13% of the forested lands in the West Virginia portion of the study area.

The dominant species in the cove hardwoods forest type are various maples, yellow poplar, and American beech; however, dominance is shared by a large number of species including, various oaks, hickories (*Carya* spp.), cherry (*Prunus* spp.), and black walnut (*Juglans nigra*), to name a few. This forest type is characterized by a diverse understory of trees that never attain canopy position such as, dogwoods (*Cornus* spp.), magnolias (*Magnolia* spp.), sourwood (*Oxydendrum arboreum*), striped maple (*Acer pennsylvanicus*), Paw-Paw (*Asimina triloba*) and redbud (*Cercis canadensis)*. Wildflowers are commonly found in this forest type because of the open canopy in the spring.

b. Appalachian Oak Woods (Oak Dominant Forests)

As the name implies, Appalachian oak woods are dominated by various species of oaks. The American chestnut (*Castanea dentata*) was co-dominant in this region until the chestnut blight of the early 1900's nearly extirpated this species. Most often Appalachian oak forests exist as mixed stands of assorted oaks and other species. Rarely is one species found in a pure stand; however, dominance of one species is often observed. For example, north-facing slopes at higher elevations are often dominated by red oaks (*Q. rubra*), likewise chestnut oak (*Q. prinus*) typically dominates at moderate elevations on dry slopes and ridgetops (Stephenson et al.,1993). Oak forests account for about 7% of the forested lands in the West Virginia portion of the study area.

At least 96 species of North American wildlife include the acorn in their diet (Stiling, 1996). Oak forests can support large populations of gray squirrels (*Sciurus carolinensis*) because of the availability of den trees and mast (nuts and fruits; Gill et al., 1975; WVDNR-Wildlife Resources, 1977). As many as 45 to 50 species of songbirds may breed in these forests because of the structural diversity of the vegetation (Samuel and Whitmore, 1979). Songbirds commonly present in this habitat include the red-eyed vireo (*Vireo olivaceus*), scarlet tanager (*Piranga olivacea*), red-bellied woodpecker (*Melanerpes carolinus*), downy woodpecker (*Picoides pubescens*), Carolina chickadee (*Parus carolinensis*), and many species of warblers (Allaire 1978; USFWS, 1978), all of whom forage on the invertebrates associated with this forest complex. Oak forests are considered to be prime habitat for wild turkey (*Meleagris gallopavo*) (WVDNR-Wildlife Resources, 1980a).

c. Northern Hardwoods (Mountain Hardwood Forests)

Northern hardwoods are restricted in the study area to cool, moist, north-facing upper slopes or ravines where cold air collects. They often intergrade with cove hardwoods on midslopes. The dominant species are American beech, sugar maple (*A. saccharum*), red maple (*A. rubrum*), and yellow birch (*Betula lutea*), with occasional stands of eastern hemlock or white pine (White et al., 1993). The canopy of this forest type is less open than that of the cove hardwoods type, and the lower layers are less developed. Witch hazel (*Hamamelis virginiana*), mountain laurel (*Kalmia latifolia*), rhododendron (*Rhododendron maximum*), spicebush (*Lindera benzoin*), hobblebush (*Vibernum alnifolium*), maple-leaf viburnum (*V. acerifolium*), deciduous holly (*Ilex* spp.), and elder (*Sambucus* spp.) are the typical shrubs in this community (Wilson et al., 1951). Approximately 9.5% of the forests in the West Virginia portion of the study area are the northern hardwood type.

Northern hardwoods are an important factor in the diversity of the fauna in the study area, because they support populations of plants and animals that are typical of the more northern forests. These include the golden-crowned kinglet (*Regulus setrapa*), Canada warbler (*Wilsonia canadensis*), red-breasted nuthatch (*Sitta canadensis*), northern water thrush [*Seiurus noveboracensis* (along shaded streams)], rock vole (*Microtus chrotorrhinus*), and long-tailed shrew (*Sorex dispar*) (Smith, 1974). American beech, sugar maple, and red maple may be used by wildlife as den trees (Wilson et al., 1951). Northern hardwood forests also contain the typical forest fauna assemblages of the region.

d. Floodplain Forests

Floodplain forests in the mountainous study area are generally restricted to narrow bands of vegetation along streams that have distinct woody and herbaceous components (Strausbaugh and Core, 1997). Characteristic woody species include, but are not limited to, black willow (*Salix nigra*), sycamore (*Platanus occidentalis*), ninebark (*Physocarpus opulifolius*), and box-elder (*A. negundo*). The herbaceous community often contains a mixture of climbing plants and erect herbs like greenbrier (*Smilax* spp.) and peppermint (*Mentha* spp.) to name a few. In the valleys, floodplains may be much broader but often times these areas have previously been converted to agricultural land use because of the fertility of the soils.

Floodplain forests have a great diversity of plant and animal species because of their association with water and because they serve as migration corridors. Some of the many species of wildlife that inhabit floodplain forests include waterfowl, songbirds, and a variety of reptiles and mammals. The moist soils associated with floodplain forests provide habitat for amphibians, particularly salamanders. Pools within the forest may provide habitat for amphibians, reptiles and invertebrates.

2. Other Forest Communities

a. Oak-Pine Forests (Hardwood/Conifer Forests and Mountain Hardwood/Conifer Forests)

Oak-Pine forests are located on south-facing slopes where the moisture level is between that of dry white oak woods and very dry pine woods. Characteristic of this forest type is a mix of oaks, pine, and often reduced numbers of hickories (Monk et al., 1990). Virginia pine (*P. virginiana*) and assorted oaks are the dominant canopy species (Bones, 1978); however, short-leaf pine (*P. echinata*) and loblolly pine (*P. taeda*) can reach abundant proportions in some areas (Skeen et al., 1993). Blueberry (*Vaccinium* spp.), huckleberry (*Galussacia* spp.), wild rose (*Rosa* spp.), hawthorn (*Crataegus* spp.), wild grape (*Vitis* spp.), and greenbrier (*Smilax* spp.) are the common woody shrubs. The herbaceous ground cover is sparse. The mixture of evergreen and deciduous trees makes this forest type particularly suitable for white-tailed deer (Gill et al., 1975), especially when this type of habitat is interspersed with pasture or silvicultural clear-cuts (Wilson et al., 1951, Skeen et al., 1993). This forest type is rare in the study area accounting for slightly more than 1% of the forested land in the West Virginia portion of the study area.

Because of their dependence on conifers for food and cover, the long-eared owl (*Asio otus*), pine warbler (*D. pinus*), black-burnian warbler, and red squirrel (*Tamiascurius hudsonicus*) inhabit the mixed oak-pine woods. Other birds commonly present include the great-crested flycatcher (*Myiarchus crinitus*) and the black-throated green warbler. Wild boar (*Sus scrofa*) forage for mast in this habitat during autumn and winter (WVDNR-Wildlife Resources 1977). Furthermore, this forest type harbors a diverse fauna of small mammals due to the abundance and variety of seeds, fruits, and nuts.

b. Pine Forests (Mountain Conifer Forests)

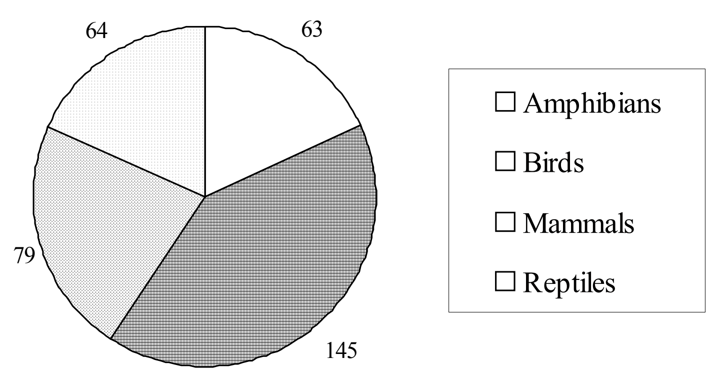
Virginia pine is the dominant species in old field habitats. Pitch pine (*P. rigida*) can become locally abundant on upper slopes with poor soils and is most often found mixed with hardwoods. Several other species of yellow pine, the short-leaf pine and loblolly pine, are of secondary importance, are essentially non-existent in the coalfields, and seldom reach dominance status outside of the Southwestern Appalachians Ecoregion. The pine forest type is often interspersed in the same part of the study area as the oak-pine forest type. The undergrowth vegetation is relatively sparse. Blueberry, mountain laurel, and dewberry (*Rubus permixtus*) are the most common species of shrubs (Wilson et al., 1951). Less than 1% of the West Virginia portion of the study area forest land is of pine forest.

The value of this habitat to most wildlife is low because of the limited availability and variety of food plants. Unless the dry pine community is interspersed with other types of habitat, it provides little more than cover (USFWS, 1978). These dry conifer stands essentially are inhabited sparsely by the same species of wildlife as those mentioned previously for the oak-pine forest type.

3. Animal Communities

Echternacht and Harris (1993) have compiled a detailed treatise on the fauna and wildlife of the southeastern United States, including the region of interest of this EIS [Figure III.F-2 - Number of Species of Terrestrial Vertebrates from the Appalachian Plateau Province]. Endemism, the localized geographic distribution of a species, is high in the region. Fourteen of the 351 vertebrate species, nine of which are amphibians, are endemic to the Appalachian Plateau Province. That is, as many as 14 vertebrate species may be found in the study area that are not found anywhere else in the world.

Figure III.F-2.
Number of Species of Terrestrial Vertebrates from the Appalachian Plateau Province



Adapted from Echternacht and Harris (1993)

The physiography of the study area allows for both northern and southern faunal components and the complex variation in local environment allows for habitat specialists. Mammal species representative of boreal (northern), temperate (warm in summer, cold in winter, moderate in spring or fall), and tropical climates are found in the Appalachian Plateau Province (Barbour and Davis, 1974).

a. Birds

Birds are amazingly diverse in the study area, due largely to the mosaic of microenvironments associated with the Appalachian Plateau Province. At least 38 families of birds can be found throughout the region. Species of birds with the greatest breeding distribution across the study area are those of forest or edge habitats and many are year round residents. Portions of the study area contain critical breeding habitat for some species of Neotropical migratory birds (Buckelew and Hall, 1994). Some of the highest concentrations of Neotropical migrant bird species like the scarlet tanager (*Piranga olivacea*), worm-eating warbler (*Helmitheros vermivorus*), Louisiana waterthrush (*Seiurus motacilla*), and wood thrush (*Hylocichla mustelina*) occur in West Virginia (Rosenberg and Wells, 2002). The mixed mesophytic forests are reported to support the richest avifauna in Kentucky (Mengel, 1965, cited in Hinkle et al., 1993) and one of the richest avifauna's in the eastern United States (Hinkle et al., 1993).

Mountaintop mining in the past has converted forest land to grasslands and in some instances shrub habitats in southern West Virginia. This change in available habitat has resulted in a shift in the distribution of birds throughout southern West Virginia with an increase in the abundance of edge and grassland bird species at reclaimed mountaintop mining sites (Wood and Edwards, 2001; Canterbury, 2001). This shift is likely apparent at mountaintop mining sites throughout the study area of this project but data supporting this claim are lacking. Many of the grassland and edge bird species now utilizing reclaimed mountaintop mining sites were once absent or rare in southern West Virginia because historically this habitat type did not occur in southern West Virginia (DeSalm and Murdock, 1993).

Eighty-four of 92 "probable" or "confirmed" breeding birds, based on data presented by Buckelew and Hall (1994) in the *West Virginia Breeding Bird Atlas*, were confirmed at mountaintop mining sites in southern West Virginia in 1999 and 2000 (Wood and Edwards, 2001)[see Appendix E for details]. The eight species not identified by Wood and Edwards (2001) are not associated with habitats associated with mountaintop mining sites (residential, urban habitats).

Species richness and abundance of songbirds is higher in shrub/pole habitats of mountaintop mining sites than in grassland, fragmented forest, and intact forest habitats (Wood and Edwards, 2001; Canterbury, 2001). The abundance of forest interior birds is significantly lower in fragmented forests near mountaintop mining sites than from intact forests near mountaintop mining sites suggesting that this bird guild is negatively influenced by mountaintop mining (Wood and Edwards, 2001). Species richness and abundance is lower on reclaimed grasslands than shrub/pole, fragmented forest, and intact forest habitats (Wood and Edwards, 2001). In general, species richness and abundance are expected to be greatest from diverse habitats, like the shrub/pole communities and lowest in the least diverse habitats, like grasslands. Studies conducted on reclaimed mountaintop mining sites in southern West Virginia support this assumption (Wood and Edwards, 2001).

Mountaintop mining sites are known to support at least ten grassland and shrub bird species not previously listed in the WV BBA (Wood and Edwards, 2001). Grassland birds are declining throughout much of the United States (Knopf, 1994). Three grassland bird species listed as “rare” in West Virginia (West Virginia Wildlife and Natural Heritage Program, 2000) are known to occupy mountaintop mining sites in southern West Virginia (Wood and Edwards, 2001). It is possible that some of the grassland bird populations on mountaintop mining sites reclaimed with herbaceous cover are existing as “sinks”. “Sink” populations are maintained by immigration because death rates exceed birth rates (Pulliam, 1988). The core breeding ranges of the ten grassland birds identified on reclaimed mountaintop mining sites are in the grasslands of the Midwest. However, data suggest that the large reclaimed grassland habitats available on the mountaintop removal/valley fill mine complexes surveyed in southern West Virginia are sufficient to support breeding populations of grasshopper sparrows with nest success rates similar to populations found in other grassland habitats. Important nesting habitat characteristics included patches of dense grassland vegetation interspersed with patches of bare ground. These habitat conditions support high densities of breeding grasshopper sparrows, even on newly reclaimed sites. As ground cover develops, however, sites will become unsuitable for grasshopper sparrows unless habitats are managed to maintain the required conditions.

Some argue that mountaintop mining has the potential to negatively impact many forest songbirds, in particular neotropical migrants, through direct loss and fragmentation of mature forest habitats. Forest-interior species like the Acadian flycatcher, American redstart, hooded warbler, ovenbird, and scarlet tanager have significantly higher populations (at least one year of the two-year study) in intact forests than fragmented forests (Wood and Edwards, 2001). Furthermore, cerulean warblers, Acadian flycatchers, and wood thrush are more likely to be found in a forested area as distance from the mine increases (Wood and Edwards, 2001). These data suggest that forest-interior bird species are negatively impacted by mountaintop mining through direct loss of forest habitat and fragmentation of the terrestrial environment.

Of the 84 bird species identified on reclaimed mountaintop mining sites in southern West Virginia in 1999 and 2000, 13 species were raptors (Wood and Edwards, 2001). Of the six species typically associated with forested habitats, the red-shouldered hawk was the most common. Red-shouldered hawks were more abundant in intact forest than in fragmented forests. Of the seven species typically associated with more open habitats, the American kestrel, northern harrier, red-tailed hawk, and turkey vulture were commonly observed as expected. Rough-legged hawks and short-eared owls were observed in low numbers in the grassland habitats. They are more northern species that use large areas of open habitat and are rarely seen in West Virginia. A pair of adult peregrine falcons was observed throughout the summer on one mine in grasslands surrounding a highwall. The falcons often used the highwall for perching, but there was no evidence of breeding.

b. Mammals

There are 18 families of mammals in the project study area and mammalian diversity is greatly influenced by the presence of species from both northern and southern forest components. The variable landscape of the study area and drastic changes in elevation allow for a complex variation in the local environment over short distances. Many mammals take advantage of this complex environment and are found specializing within the project area (Wilson and Ruff, 1999). For example, the masked shrew (*Sorex cinereus*) is a common inhabitant of the coniferous and northern deciduous forest biome, but the peak of its southern range extends into the project area where it thrives in moist, cool forests (Merritt, 1987) like the cove hardwoods.

Small mammal species richness does not differ between grassland, shrub/pole, fragmented forest, and intact forest habitats from mountaintop mine sites in southern West Virginia (Wood and Edwards, 2001) [see Appendix E for details]. Small mammal species abundance tends to be greater in grassland and shrub/pole habitats than in fragmented and intact forest habitats (Wood and Edwards, 2001). Rip-rap filled drainage ditches on reclaimed mine sites provide habitat for the Allegheny woodrat (*Neotoma floridana*) (Wood and Edwards, 2001), which is listed as threatened, endangered, or a species of special concern by the states of Indiana, Maryland, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Virginia, and West Virginia. No studies are available that address the possible impact that mountaintop mining has on bats and larger mammals. There is, however, anecdotal evidence that mining has had a positive impact on white-tailed deer (*Odocoileus virginianus*) populations in the study area.

c. Herpetofauna

Five families of lizards and skinks, four families of turtles, and two families of snakes make-up the reptile assemblage of the study area. Four species of reptiles are endemic to the Appalachian Plateau Province of the study area (Echternacht and Harris, 1993). Endemism may be greater along the plateau because climatic conditions are more stable than the other ecoregions of the study area (Green and Pauley, 1987). Among the amphibians of the study area are five families of frogs and toads, and five families of salamanders. The southern Appalachians have one of the richest salamander faunas in the world (Petranka 1998, Stein et al 2000). Petranka (1993) presented a conservative estimate that there are about 10,000 salamanders per hectare of mature forest floor in Eastern forests.

Over a two-year study (2000 and 2001) of mountaintop mining sites in southern West Virginia, 1750 individuals were captured or observed using drift fence arrays, stream searches, and incidental sightings (Wood and Edwards, 2002). Of a possible 58 species expected to occur in the study area, 41 were encountered. The 41 species included 12 salamander species, 10 toad and frog species, 3 lizard species, 13 snake species, and 3 turtle species.

Amphibian and reptile species richness and abundance does not differ between grassland, shrub/pole, fragmented forest, and intact forest habitats from mountaintop mine sites in southern West Virginia (Wood and Edwards, 2001)[see Appendix E for details]. Salamanders appear to be less common in the grasslands of reclaimed mountaintop mining sites than in the nearby forests (Wood and Edwards, 2001). Herpetofaunal species, like salamanders, that require loose soil with ample ground cover, are generally absent from reclaimed mountaintop mining sites (Wood and Edwards, 2001). Salamanders are an important ecological component in Eastern forests (Burton and Lykens, 1975; Hairston, 1987) and salamander populations appear to recover slowly following forest clearing and disturbance (Bennett et al., 1980; Pough et al, 1987; Ash, 1988; Petranka et al., 1999). Mountaintop mining results in greater soil disturbance than forest clearing so a longer time may be required for recovery of salamander populations from mountaintop mined sites.

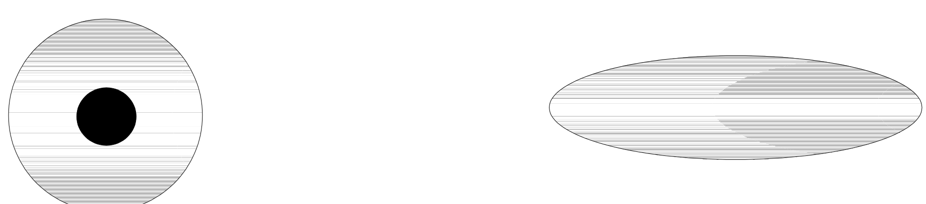
4. Interior Forest Habitat and Area Sensitive Species

A variety of wildlife species require large tracts (hundreds to thousands of acres) of continuous forest cover. Interior forest habitats are relatively rare and easily lost. Disturbance regimes, like agriculture, mining, and suburban sprawl, decrease interior forest habitat while increasing forest edge habitat, thus affecting the composition and distribution of wildlife within the region. For example, much of the avifauna (birds) of the study area depends on large areas of interior forest habitat for their survival (Robbins, 1980; Askins, 1993; Buckelew and Hall, 1994; Patton, 1994; Robbins et al., 1989). For example, the black-and-white warbler (*Mniotilta varia*) is an area-sensitive species usually not found in forest tracts less than 200 hectares (about 500 acres). Similarly, the worm-eating warbler (*Helmitheros vermivorus*) seems to require forest tracts of at least 150 hectares (370 acres). While other bird species, like the ovenbird (*Seirus aurocapillus*) and the Kentucky warbler (*Oporornis formosus*), are indirectly dependent on large tracts of interior forest because of their extreme susceptibility to brown-headed cowbird (*Molothrus ater*) parasitism in forest edge habitats.

Brown-headed cowbirds are found in very low abundance at reclaimed mountaintop mining sites in southern West Virginia; subsequently, nest parasitism is not likely a significant cause of nest loss in the study area (Wood and Edwards, 2001). Whether or not mountaintop mining has a negative effect on the breeding success of forest interior bird species through direct loss of interior forest habitat remains in question. Studies conducted at reclaimed mountaintop mining sites in southern West Virginia have yielded forest interior bird species in shrub/pole and fragmented forest habitats as well as intact forest habitats (Wood and Edwards, 2001; Canterbury, 2001). However, the abundance of forest interior bird species was significantly lower in fragmented forests than intact forest, suggesting a detrimental impact (Wood and Edwards, 2001). Canterbury (2001) suggests that studies of nesting success are needed to determine if mountaintop mining is having a negative impact on forest interior bird populations. Intuitively, it makes sense that the loss of interior forest habitat would be detrimental to wildlife populations dependent upon such habitat.

Not all large forest tracts contain interior forest habitats [Figure III.F-3 - Relationship Between Patch Shape/Size and Interior Forest Habitat]. A long, narrow forest patch may be comprised entirely of edge species. Thus, when considering the needs of area sensitive species the shape of the forest tract must be considered.

Figure III.F-3.
Relationship Between Patch Shape/Size and Interior Forest Habitat



Assume both patches are of equal area. The patch on the left contains interior forest habitat (solid shade) while the patch on the right is entirely edge habitat (dot shade).

5. Deforestation

DEFORESTATION AFFECTS WILDLIFE BY DIRECTLY REMOVING AVAILABLE HABITAT FOR SOME SPECIES WHILE OPENING THE FOREST AND PRODUCING HABITAT FOR OTHER SPECIES. FURTHERMORE, INDIRECT AFFECTS OF DEFORESTATION MAY INCLUDE INCREASED SOIL EROSION, LEADING TO SILTATION OF AQUATIC HABITATS, EUTROPHICATION OF AQUATIC HABITATS BY ACCELERATED NUTRIENT RELEASE, THE CONVERSION OF FOREST HABITATS TO RANGELANDS OR SUCCESSIONAL FIELDS, AND A CHANGE IN THE REGION'S CONTRIBUTION TO GLOBAL PRIMARY PRODUCTION (STILING, 1996).

Energy accumulated by plants is referred to as primary production. The energy remaining after plant respiration and stored as organic matter is net primary production. Globally, temperate forests produce approximately 13% of the worlds net primary production per year (Whittaker, 1975). Temperate forests also provide habitat for a large proportion of the study area's wildlife. The Land Use Assessment study concludes that approximately 5% of the West Virginia mountaintop mining study area contained evidence of having been disturbed by past or current mining [Appendix G]. Deforestation results in both habitat loss and fragmentation of the terrestrial environment.

Habitat loss is generally understood to be the single most important cause of wildlife population declines and a threat to present-day wildlife populations (Illinois Wildlife Habitat Commission, 1985). It follows that the deforestation of large portions of the Appalachians through mountaintop mining is a significant concern from the standpoint of forest-dwelling wildlife, in particular, forest interior species. On the other hand, the loss of forested habitats is equaled by a gain in other habitat types, like grasslands.

There is disagreement about what these changes in the terrestrial environment mean. Many point out that reclamation efforts have created habitat, like grasslands, edge habitat, and scattered ponds, that are important for game species such as wild turkey, bobwhite quail (*Colinus virginianus*), ruffed grouse (*Bonasa umbellus*), and white-tailed deer. Many grassland and shrub bird species, previously unrecorded as having breeding populations in southern West Virginia, are known to breed on reclaimed MTM/VF sites (Wood and Edwards, 2001). Among these grassland songbirds is the grasshopper sparrow (*Ammodramus savannarum*), which is listed as "rare" by the West Virginia Wildlife and Natural Heritage Program (2000) but is found to be abundant and breeding successfully on Mountaintop mining sites (Wood and Edwards, 2001). Two other "rare" species in West Virginia (West Virginia Wildlife and Natural Heritage Program 2000), the bobolink (*Dolichonyx oryzivorus*) and Henslow's sparrow (*A. henslowii*), were present at some mountaintop mining sites but not confirmed as breeding (Wood and Edwards, 2001). Furthermore, with the exception of a few rare species, the densities of songbirds on grassland and shrub/pole mountaintop mining sites was similar to that reported in other studies indicating that the quality of habitat and availability of resources is similar to other sites (Wood and Edwards, 2001). It should be noted that the presence of rare, threatened, and endangered species in these reclaimed habitats is more likely a result of the habitat being rare in the study region than the species being rare. That is, many of the rare species encountered at mountaintop mining sites are common or abundant in other parts of the United States where their required habitat is more abundant.

The above findings provide evidence that mountaintop mining practices provide favorable conditions for some species. However, these advantages may not surpass the disadvantages these practices have on the sustainability of plants and wildlife in the region.

Historically, vegetative communities of the Appalachians have undergone much change beginning with the replacement of pine and spruce forests by oaks, due to climatic warming about 10,000 years ago (Abrams, 1992). Humans began to alter the Appalachian vegetative communities about 1,000 to 3,000 years ago, increasing the extent of oak-chestnut forests, due to use of fire (Delcourt and Delcourt, 1998). More recently in the 1800's, logging, increased fire, clearing of forests for settlement, and the loss of the American chestnut (*Castanea dentata*) to chestnut blight fungus have led to massive changes in the vegetative communities of the Appalachians (Nowacki and Abrams, 1991). Possibly, the greatest impact to Appalachian vegetative communities was exerted by the logging industry. Clearing of forests leads to soil erosion, drying of understory, increased fires, and the depletion of soil nutrients. Logging has decreased dramatically in the study region since the 1940's, and coupling this with the abandonment of old farms has led to an increase in forest area for the region over the past 50 years (Barrett, 1995). Approximately 244,000 acres in the West Virginia portion of the study area have been disturbed by past or current mining (Yuill, 2001).

Mountaintop mining operations in the Appalachian coal fields involve fundamental changes to the region's landscape and terrestrial wildlife habitats. Prior to 1998 (the start of this EIS) with the increasing size of these operations, a single permit involved changing thousands of acres of hardwood forests into herbaceous cover. This is true even for the short-term when forest is post-mining land use. While the original forested habitat was crossed by flowing streams and was comprised of steep slopes with microhabitats determined by slope, aspect, and moisture regimes, the reclaimed mines are often limited in topographic relief, devoid of flowing water, and most commonly dominated by erosion-controlling, herbaceous communities. Islands of remnant hardwood vegetation may be present on some of the reclaimed mines, and some planting of trees and shrubs may have been undertaken.

Handel (2001) studied 55 mountaintop mining sites in southern West Virginia that were reclaimed with herbaceous vegetation and ranged in age from 6 to 24 years. Handel (2001) determined that trees and shrubs are extremely low in abundance and number on mine sites compared to surrounding forests. Reclaimed sites where trees and shrubs were invading tended to be dominated by two or three species whereas the surrounding forests were very species rich. The invasion rate of native trees and shrubs onto mined sites is most likely restricted by excessive soil compaction, large mining area, poor soil quality, and the application of grassy mixes for erosion control. Furthermore, Handel (2001) found that there were 17 fewer forest herb species on plots adjacent to mountaintop mining sites than in interior forests. This effect extended from the edge of the reclamation area 50 m into the forest.

a. Forest Fragmentation

The phrase "forest fragmentation" describes a formerly continuous forest that has been broken into smaller pieces (Jones, 1997). The disruption of continuous forest habitats into isolated and small patches may have two negative affects on biota dependent upon forest habitat: decreased area and increased isolation of the remaining patches (Meffe and Carroll, 1994). However, disruption also provides habitat for those species that thrive within the ecotone of forest and open habitat.

Fragmentation leads to a decrease in the abundance of many species of songbirds in the study area (Wood and Edwards, 2001). Wood and Edwards (2001) list ten species of forest-dwelling songbirds that are negatively impacted by forest fragmentation. Since native trees and shrubs have a slow invasion rate on mined sites (Handel, 2001) we can assume that the invasion rate of area sensitive forest-dwelling songbirds will be even slower. Similarly, we can assume that the invasion of rate of forest-floor dwelling salamanders will be slow on post-mined sites. Wood and Edwards (2001) found that taxa dominance shifted from salamanders to snakes when intact forests were converted to grasslands through reclamation of mountaintop mining sites. Populations of many eastern forest amphibian species are largely dependent upon coarse woody debris, litter moisture and depth, density of understory stems, and canopy cover (deMaynadier and Hunter, 1995). These are traits absent on most post-mining sites and traits that appear to be slow to return to reclaimed mountaintop mining sites.

b. Forest Edge Habitat, Edge Effect

Edge habitat occurs at boundaries between different types of land cover. Certain species require resources in two or more vegetation types and thus require edge habitat. The outer boundary of a habitat patch is a zone that varies in width depending on the variable being measured. For example, edge zones are usually drier and receive more sunlight than interior forests, and thus have a different floral composition, which favors shade-intolerant species. Climatic edge effects, such as this, may have a negative effect on interior species of the patch through altering of the physical environment and increasing competition for resources. On the other hand, due to the different microclimate associated with the edge ecotone; these habitats are often more diverse than the interior habitat and contain unique wildlife assemblages (Yahner, 1988).

Edge effect is used to describe the negative influence, like the microclimatic differences described above, that edges have on the interior of a habitat and on the species that use the interior habitat. However, edge effect can be used to describe the increase in edge species richness often observed at the ecotone of forest edges.

Many species of wildlife are attracted to “edges,” or areas where two or more different habitat types come together. This fact has been the basis for traditional wildlife management schemes (including those recommended by State resource agencies for mine reclamation), which seek to promote edges to maximize “biodiversity.” However, as explained by Heckert et al. (1993), promoting edges at the expense of large habitat blocks can lead to *lower* wildlife diversity:

> Wildlife diversity can be viewed on two different levels. On one level, diversity can be viewed as the number of species that occur on a single tract of land, such as private landholdings, single fields, or woodlots. On the other level, diversity can be viewed as the number of species that occur within a larger geographic area such as large conservation areas, counties, and watersheds.
>
> Land management focused entirely on providing abundant edge has come under recent criticism because it can exclude species that require large uniform habitat blocks or do not survive near edges. If most parcels are managed to increase edge, only those species tolerant of edges will prosper. Species needing uniform habitat blocks away from edges can be eliminated. The result of such management will be

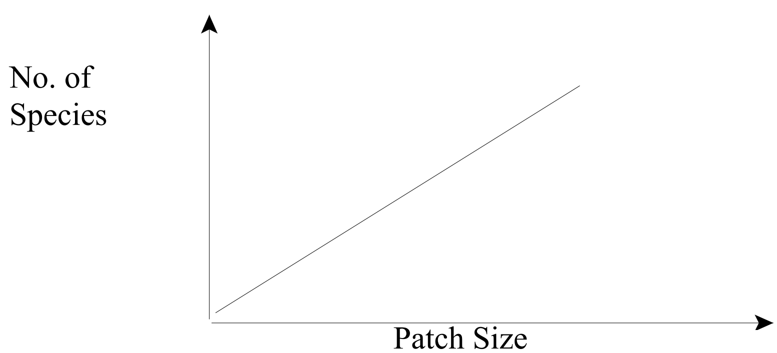
> lower wildlife diversity within large geographic regions because area-sensitive species will be lost. Conversely, the maintenance of large habitat blocks for area-sensitive species will not result in the loss of edge species as some edges will always be present in the landscape... If land use patterns and management continue to favor edge species, continued population declines and possibly local or regional extinctions of area-sensitive species are likely to occur.

Edge habitat on reclaimed mountaintop mining sites in southern West Virginia is utilized by bird species of different guilds depending upon the habitats creating the edge. For example, edge composed of grassland and fragmented forest tend to be dominated by birds of the grasslands bird guild while edge composed of forest and shrublands tend to be dominated by birds of the forest-interior and edge guilds (Canterbury, 2001).

c. Patch Size

Patch size refers to the area of a particular habitat or reserve within a landscape. The basic species-area relationship implies that larger patches capture a greater number of species of a region than do smaller patches [Figure III.F-4 - Relationship Between Species Richness and Patch or Island Area]. This is due, in part, to an increase in habitat heterogeneity as the patch size gets larger. Larger patches are also more likely to be able to accommodate disturbances than smaller patches. As patch size decreases, forest edge-to-volume ratios increase, thereby increasing edge effects and reducing the amount of true interior habitat.

Figure III.F-4.
Relationship Between Species Richness and Patch or Island Area



Adapted from MacArthur and Wilson (1963)
Adapted from MacArthur and Wilson (1967)

Another aspect of patch size is isolation. Small, isolated patches are more prone to local species extinctions than large patches and small groups of closely spaced patches, because they are less likely to be colonized. Therefore, when circumstances require or result in the creation of small patches, it is important to space them close together or to provide some form of connectivity between the patches.

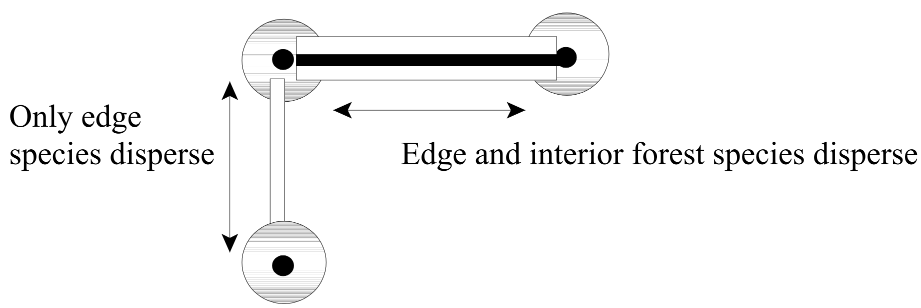
Many species require large patch sizes for their survival. For example, the cerulean warbler is a common bird of mixed mesophytic and Appalachian oak forests in West Virginia. This migratory species commonly occupies the heavily-leafed canopy of mature forests during summer months and is rarely seen. Studies suggest that a minimum area of 700 hectares (1,730 acres) is required for sustaining a viable population of this species (Buckelew and Hall, 1994). Reduction of forest patch size and the fragmation of habitats may greatly affect the distribution and abundance of the cerulean warbler. Conversely, smaller patch sizes are favored by many species, including many game species that depend upon food sources, nesting sites, and ground cover associated with small forest patches.

d. Corridors

As habitats become fragmented into small patches, there is a change in distribution and abundance of species, due to such factors discussed above as isolation and decreased interior habitat. An intuitive solution to this problem is the reconnection of these fragmented habitats through habitat corridors. Corridors allow for species movements, and thus, recolonization among isolated habitats.

Simple corridors, called line corridors, consist entirely of edge habitat and allow for the movements of edge species [Figure III.F-5 - Corridors Connect Patches in a Fragmented Environment]. In contrast, strip corridors contain some interior habitat that is required for the movements of many large animals, in particular, predatory mammals and forest interior species. Patches that are farther apart may require broader corridors in order to be effective (Harrison, 1992). Whereas, line corridors may suffice for closely spaced patches.

Figure III.F-5.
Corridors Connect Patches in a Fragmented Environment



Corridor width can act as a filter by selecting for the dispersal of some species while limiting the dispersal of other species.

Despite the obvious advantages of corridors, disadvantages do exist. For some species, like small mammals, predation may increase in corridors because of the reduction in interior habitat and cover. Furthermore, species may be pulled into a sink corridor where rates of survival and extinction differ from their source habitat (Soule, 1991). Another disadvantage of corridors is that they may provide access for unwanted species, such as, invasive exotics to invade once unoccupied areas.

Public concerns voiced before the conception of this EIS included fears that mountaintop mining may contribute to the spread of exotic and invasive species. One concern was that roads and fragmentation of the environment associated with mountaintop mining may act as line corridors aiding in the spread of exotic and invasive species. There is no evidence that mountaintop mining has contributed to the spread of invasive and exotic species in southern West Virginia (Handel, 2001).

6. Carbon Sequestration

The energy flow in terrestrial ecosystems depends on interactions between a number of biogeochemical cycles such as the carbon cycle and hydrological cycles. Terrestrial ecosystems play a role in the global carbon cycle. Carbon is exchanged between trees and the atmosphere through photosynthesis and respiration. The cycling of carbon as carbon dioxide involves assimilation and respiration by plants.

According to the World Resource Institute (1997), drawing carbon dioxide out of the atmosphere (sequestration) and into biomass is the only known practical way to remove large volumes of this greenhouse gas from the atmosphere. Reforestation could potentially achieve significant carbon sequestration. It has been estimated that temperate forests sequester 0.6 to 1.8 tons of carbon per acre per year as reported by the Intergovernmental Panel on Climate Change (2001).

G. RELATIONSHIPS OF MOUNTAINTOP MINING TO SURFACE RUNOFF QUANTITY AND FLOODING

The central Appalachian physiographic region is a highly dissected plateau characterized by high, tree-covered hills and deep, narrow valleys. Large watersheds often feed streams with narrow valleys and small flood plains. In such rugged terrain, people live near or adjacent to the streams and rivers, and they may consequently be flooded during large rainfall events.

MTM/VF mining causes alterations in the topography and drainage patterns in the mined areas. There are also changes in vegetation and ground cover that are associated with this type of mining. The combination of these alterations can impact the amount of runoff from the mined area for a given storm event. That impact and possible cumulative effects from similar or multiple projects has been raised as a concern for analysis in these watersheds.

As part of the background assessment of the effects of mountaintop mining on the environment, a number of studies were undertaken to evaluate whether MTM/VF operations resulted in an increased risk of flooding to downstream communities. The following summarizes the findings of these studies, along with an introductory background on the existing regulatory framework with respect to control of surface mine runoff and flooding risks.

1. Regulatory Background

Surface water impacts from surface mining were recognized during the development and implementation of SMCRA. These potential impacts were discussed in the Final Environmental Statement OSM-EIS-1 for SMCRA. The discussion noted that surface mining can have significant effects on surface hydrology. Removal of vegetation, new drainage patterns, storage of water on benches or in ponds, drainage of surface water into underground mines and alternate ground cover change the runoff characteristics. These changes in runoff may cause scouring and erosion of unprotected stream channels and can contribute to downstream flooding. Small tributaries with a high percentage of recently disturbed land may have somewhat higher flood levels as a result of the surface mining. Increased flooding might be attributed to inadequate reclamation or inadequate drainage control structures. However, there are also reports that document surface mining effects with a lower flood rate than a similar unmined watershed (Davis, 1967; Collier and others, 1970; Curtis, 1972, Curtis, 1977). Open pits at mines sites can provide significant runoff retention. Drainage control structures can also provide retention, plus longer travel times for overland flow. The increased infiltration provided by backfills can also retard or lessen peak flows.

Surface mining may cause isolated flooding events related to failure of erosion and sedimentation control structures. In a recent incident, a mine sediment ditch in Mingo County, West Virginia, ruptured during a rainfall event and damaged downhill properties, including fences, a bridge, and a vehicle (Associated Press, 2000). Storm water control structures on surface mine sites are designed to accommodate a given storm frequency event, a statistical abstraction of the largest storm event that can be expected to occur within a given time period. In reality, there is no reason that a larger storm could not occur within that time period, only that it is less likely, so a probability always exists that storm water control facilities on mining sites or in any other application can be overwhelmed and fail. Mechanical failure due to improper construction is also a possible source of isolated flooding incidents.

SMCRA and USOSM regulations require that flooding potential be addressed in the design requirements of coal mine permits and the consideration of offsite impacts to the hydrologic balance. Water diversions are required to be designed and constructed to provide protection against flooding and resultant damage to life and property (30 CFR 816.43(a)(2(ii)). USOSM regulations also require the operator to make a "Probable Hydrologic Consequences Determination"(PHC) as part of the permit application (30 CFR 780.21(f)). The PHC is required to specifically address flooding and stream flow alterations as part of this determination. USOSM regulations further require the regulatory authority to provide a "Cumulative Hydrologic Impact Assessment"(CHIA) as part of the permit approval process (30 CFR 780.21(g)). This hydrologic assessment must include the impacts of the proposed operation and all anticipated mining on surface and ground water systems in the cumulative impact area. Currently, not all of the state regulatory agencies require a quantitative analysis of flooding impacts for proposed mine operations in either the PHC or CHIA assessments.

The USCOE routinely relies on state or SMCRA regulations to address flooding. The USCOE may evaluate flooding impacts from an individual mine. The USCOE districts routinely consider flooding impacts when they evaluate mining activities under the Individual Permit process. The need to do a separate flood impact analysis is determined on a case by case basis by the USCOE. Most districts will not conduct a separate flood analysis if such an analysis is required by state or SMCRA regulations.

2. EIS Peak Flow Studies

Previous studies of peak flow evaluated sites that were not specifically impacted by MTM/VF mining and were done prior to the implementation of SMCRA. To fill in this information and analysis gap several studies were done in preparation of this EIS. The EIS studies evaluate the impacts of MTM/VF mining on peak flow using computer modeling, continuous data collection using stream gages, post-flood highwater marks, on-site drainage control structure evaluation, and citizen complaint investigations. Each study analyzes discrete circumstances that help to create a more complete evaluation when coupled with the other EIS studies. The output from these efforts is summarized and discussed below. The complete studies are presented in Appendix H.

USOSM and the Army COE (Pittsburgh District) performed computer model analysis of peak flows at locations immediately downstream of several drainages where valley fills were planned in West Virginia. Specific design precipitation events were modeled for these drainages using a variety of scenarios. This study provided the predicted peak flows for several mining and reclamation plans. This is referred to as the "Peak Flow" Study.

The USGS - Water Resources Division (Charleston, West Virginia) installed and maintained three continuous recording stream gages and four rain gages in a small watershed in West Virginia. The stream gages were located to documented the stream-flows for a mined area with a valley fill, an adjacent unmined area, and the cumulative discharge downstream of these areas. This study provided the actual peak flows for the various rainfall events that occurred during the period of data collection. This is referred to as the "Fill Hydrology" study.

The USGS - Water Resources Division (Charleston, West Virginia) evaluated the peak flows for the July 8-9, 2001 flooding in southern West Virginia. Six small drainage basins were selected and the highwater marks were documented immediately after the floods. The highwater marks and stream channels were surveyed and peak flows were calculated from this data using "indirect discharge measurement techniques." This study provided the calculated peak flows for an individual extreme event that caused flooding and damage in and around the study area. This is referred to as the "July 2001 Floods" study.

USOSM and the KYDSMRE did a special study on drainage control at mine sites in Kentucky. Site selection was based on citizen complaints alleging that life-threatening "washouts" were caused by mining or otherwise significantly contributing to downstream flooding and/or flood-related adverse impacts to citizens, property or the environment. This is referred to as the "OSM/Kentucky Oversight" study.

USOSM did an evaluation of citizen complaint records for West Virginia, Kentucky, and Virginia where there were allegations of flooding from coal mine operations. Thousands of citizen complaints received and investigated by these states and those related to flooding were reviewed. This is referred to as the "Citizen Complaint" study.

a. Peak Flow Study

In November 1997, an interagency coordinating meeting of the Federal Regulatory Organization Group (FROG) was held in Berkeley Springs, WV. One of the topics for discussion was a more "pro-active" approach in response to valley fill permit applications with respect to Section 402 and 404 (CWA) permit applications, as well as related USOSM and state permitting and administrative procedures. The EPA, OSM, COE, and FWS formed a four-agency task force to evaluate valley fill issues. Flooding was one of the issues chosen for technical investigation by the four agency group.

OSM and the COE performed a model analysis of potential downstream flooding as a result of valley fills and large scale surface coal mining operations in Appalachia. The purpose of the Peak Flow Study was to evaluate the potential for flooding as a result of the construction of valley fills and the related hydrologic modifications to terrain associated with MTM/VF mining. The following summarizes the computer modeling studies that have been undertaken as part of the Peak Flow Study and the conclusions that have been reached.

Computer modeling simulations were performed to evaluate the impacts of rainfall events on three individual valley fills, as well as the cumulative impacts of two of these fills on a downstream area. The study used computer models to predict storm hydrograph peak discharges for two precipitation events (10-year and 100-year) during various scenarios of pre-mining conditions, conditions during mining, initial post-mining conditions with no change to the permitted regrading plan, future post-mining conditions with forest cover assumed for the permitted regrading plan instead, and initial post-mining conditions for a conceptual Approximate Original Contour Plus fill optimization process (AOC+ - also referred to as the WVDEP AOC Process) regrading plan. The USCOE-developed Hydrologic Engineering Center (HEC) computer model was used by the USCOE (Pittsburgh District), and the proprietary SEDCAD 4 model was used by USOSM, to evaluate three valley fill watersheds in southern West Virginia. Both models used the identical topographic and land use conditions, which provided a useful comparison of the surface water modeling software. Both software models are readily available to private consultants. SEDCAD 4 is frequently used by the coal industry to design diversions and sediment control structures, while the HEC model is used for a wide variety of watershed hydrology studies.

The point of evaluation of the peak flows for the HEC-HMS and SEDCAD 4 modeling was the permit boundary downstream of each valley fill. The sites selected were all Arch Coal Company sites: the Samples Mine Valley Fill #1, Samples Mine Valley Fill #2, and Hobet Mine Westridge Valley Fill. The Samples Valley Fill #1 drainage area was 440 acres, with 72 percent of the area disturbed by mining operations or valley fill. The Samples Valley Fill #2 drainage area was 351 acres, with 56 percent of the area disturbed. The Hobet Westridge Valley Fill drainage area was 1600 acres, with 74 percent of the area disturbed.

As summarized by Table III.G-1, the storm runoff modeling using HEC-HMS and SEDCAD 4 both calculated that the post-mining peak flows would be higher than the pre-mining peak flows for the same design storms. However, the predicted increases in peak flow would not have caused flooding on the banks outside the receiving stream channel.

The USCOE (HEC-HMS) analysis predicted peak flow increases of about 3 percent for Samples Valley Fill #2, 13 percent for Samples Valley Fill #1, and 42 percent for Hobet's Westridge Valley Fill between pre-mining and permitted post-mining conditions. These results indicate the largest drainage area (Hobet Westridge Valley Fill) with the highest percentage area disturbed had the greatest increase in peak flow from pre-mining conditions. The results also indicate that the smallest drainage area (Samples Valley Fill #2) with the smallest percentage area disturbed had the lowest increase in peak flow.

The USCOE study also completed a cumulative analysis of the Samples Valley Fills #1 and #2. The fill drainage areas are adjacent to each other and form the headwaters of the same stream. The cumulative analysis indicates an increase in the peak flow downstream of the valley fills at a point below where the two drainages converge. However, the peak flow increase (8 percent) between pre-mining and permitted post-mining conditions represents influences of the individual valley fill drainage areas and any additional drainage area that flows to the cumulative analysis point. The influence of changes in the headwater areas will decrease as the point of analysis is moved further downstream. That is, the peak flow alteration would attenuate downstream from the mine site.

Table III.G-1
Comparison of HEC-HMS and SEDCAD 4 Models Peak Flow Results

Peak Flow Predictions in Cubic Feet Per Second (CFS)										
Storm Event	**Pre-Mining**		**During Mining**		**Permitted Post-Mining**		**AOC+ Post-Mining**		**Permitted Post-Mining Forested**	
Samples Mine Valley Fill #1										
	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4
10 Year	330	352	525	498	376	447	432	416	246	269
100 Year	742	739	931	844	832	864	932	790	580	583
Samples Mine Valley Fill #2										
	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4
10 Year	293	326	---	---	302	354	295	391	209	259
100 Year	664	768	---	---	671	688	658	744	502	563
Samples Mine Valley Fills #1 and #2 Combined										
	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4
10 Year	765	803	---	---	826	880	833	---	605	---
100 Year	1711	1693	---	---	1793	1722	1874	---	1331	---
Hobet Mine Westridge Valley Fill										
	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4	HEC-HMS	SEDCAD 4
10 Year	838	782	---	---	1193	855	---	---	---	---
100 Year	1736	1447	---	---	2459	1525	---	---	---	—

The USCOE documented channel capacity with measured survey sections for streams below each site. These measurements allow an evaluation of the effect of modeled peak flows on water levels of the receiving stream downstream from each fill. Changes in water level are related to the flow volume and the cross-sectional area of the stream channel. The water level increases in the receiving stream were negligible for the Samples Valley Fill #2; 0.3 feet for the Samples Valley Fill #1; and 2.1 feet for the Hobet Westridge Valley Fill between pre-mining and permitted post-mining conditions. Routing design storm peak flows through these measured channel sections did not cause flooding because resultant water levels were below bank-full conditions within the receiving stream.

The same topographic and hydrologic conditions were used by USOSM to predict peak flows using the SEDCAD 4 hydrology model. Similar to HEC-HMS, the SEDCAD 4 model predicts the post-mining peak flows to be higher than the pre-mining peak flows. While the SEDCAD 4 percentage increases would not be expected to be identical to those predicted by the HEC-HMS model, the general finding that permitted post-mining peak flows will be higher was confirmed by SEDCAD 4 as well.

The one analysis of peak flows during mining for the Samples Mine Valley Fill #1 showed a 59 percent and 25 percent increase over pre-mining conditions for the 10-year and 100-year storm events, respectively. Water level increases were 1.7 feet and 1.3 feet, respectively, compared to pre-mining conditions. Again, this did not result in any predicted overbank flooding.

Predicted runoff for conceptual AOC+ conditions was 12 percent higher for the Samples Mine Valley Fill #1 than permitted post-mining configuration, whereas the peak flow was 2 percent lower for Valley Fill #2. For the combined valley fills, peak flows were 1 percent and 5 percent higher for the 10-year and 100-year storm events, respectively, for AOC+ conditions versus permitted post-mining conditions. In comparison, peak flow increases for AOC+ ranged from 1 percent less than pre-mining conditions to 31 percent more, whereas the permitted post-mining peak flows ranged from 1 percent to 13 percent more than pre-mining conditions. Water level increases ranged from negligible on the Samples Mine Valley Fill #2 to 1 foot on the Samples Mine Valley Fill #1, with no overbank flooding predicted.

The final analysis was made of future conditions if the Samples Mine sites were forested with the permitted post-mining configuration. This showed substantially lower peak flows than either the initial post-mining conditions or the pre-mining conditions. Predicted forested peak flows ranged from 22 percent to 29 percent lower than pre-mining conditions, and 25 percent to 35 percent lower than initial permitted post-mining conditions. Water levels at the receiving stream analysis points decreased from 0.4 feet to 1 foot compared to pre-mining conditions among the sites evaluated.

The storm runoff modeling using HEC-HMS and SEDCAD both calculated that the permitted post-mining and AOC+ post-mining peak flows would be higher than the pre-mining peak flows for the same design storms. However, increases in peak flow did not cause a rise in water level overtopping the receiving stream channels. Flooding typically occurs only when water levels exceed channel capacities and spread across the flood plain where residential settlements may occur. The cumulative analysis of two fills indicated an increase in the peak flow post-mining beyond the downstream confluence of the valley fill watersheds. Again, bank full capacity of the stream channel did not result. The influence of changes in the headwater areas will decrease as the point of analysis is moved further downstream.

b. Fill Hydrology Study

The USGS collected data in close proximity to several mountaintop mines to document the changes in flood peaks associated with these sites. Rainfall and runoff are being measured at four rain gages and three stream gages. The stations are in the Ballard Fork watershed near Mud, West Virginia. Data collection began in November 1999 and is continuing. The stream gages were located to document the stream flows for a mined area with a valley fill (0.19 sq. mi.), an adjacent unmined area (0.53 sq. mi.), and the cumulative discharge downstream of these areas (2.12 sq. mi.). The stream gages provide continuous records of water surface elevations for each station. These water surface elevations are converted to stream flow based on actual flow measurements taken at various water surface elevations. Peak flows and the hydrographs for each precipitation event can then be evaluated.

The precipitation gages provide a continuous record of rainfall that can be evaluated for total amount of rainfall and the rainfall intensity. These records also document and allow for the evaluation of time since the previous rainfalls to estimate the soil moisture conditions. Most of the intense rainfall in the study area occurred during summer thunderstorms.

The storm hydrographs for the mined watershed were distinctly different from the hydrographs for the unmined watershed and the cumulative watershed. The unmined and cumulative watersheds generally rose in response the rainfall events and was independent of rainfall intensity. In contrast, the storm hydrograph for the mined watershed had a double peak flow when rainfall intensity exceeded about 0.25 in/hour. The hydrograph would rise quickly to the first peak flow and recede quickly after the heavy rainfall stopped. There would then be a second peak flow that was not as high as the first but would occur hours after the first peak.

During most of the recorded storms (low intensity) the peak flows (per unit area) for the unmined watershed and the cumulative watershed were less than the mined watershed. However, during intense rainfall events the peak flows (per unit area) for the mined watershed were greater than those for the unmined and cumulative watersheds.

c. July 2001 Floods Study

The USGS investigated the effects of valley fills on the peak flows for the flood of July 8-9, 2001 in West Virginia. Six small basins (drainage areas ranging from 0.189 to 1.17 sq. mi.) within an area of about 7 sq. mi. in the headwaters of Clear Fork of the Coal River in southern West Virginia were investigated following the July floods. Three of the basins were downstream from the ponds at the toe of valley fills and three basins were not below valley fills.

The thunderstorm that produced the July 8-9, 2001 floods produced rainfall amounts between 3 and 6 inches in a 5 to 6 hour period. These rainfall amounts for this storm alone were approximately equal to the average monthly rainfall.

Within the six small drainage basins the highwater marks were documented immediately after the floods. The highwater marks and stream channels were surveyed and peak flows were calculated from this data using “indirect discharge measurement techniques.” From this information and the roughness coefficients (ground-surface conditions) the peak flow can be calculated. These flows were divided by the drainage area for the basin to produce a unit peak flow.

The six basins were separated into a northern group and a southern group. They were grouped by geographic location and the relative difference in the unit peak flows for the unmined watersheds. There are four basins in the southern group where two had valley fills and two did not. The remaining two basins were in the northern group with one valley fill basin and one without.

The calculated unit-peak flows for the unreclaimed valley fill in the southern group was twice as high as the remaining sites. The remaining basins in the southern group had similar unit peak flows for the unmined watersheds and the reclaimed valley fill.

The calculated unit-peak flows for in the northern group showed a different relationship. The watershed without the valley fill had a unit-peak flow that was twice as high as the watershed with a valley fill.

d. Citizen Complaints Study

The citizen complaint records for West Virginia, Kentucky, and Virginia were reviewed for allegation of flooding from coal mine operations. Of the thousands of citizen complaints received and investigated by these states, a very small percentage were related to flooding. Of those flooding-related complaints found to be mining-related, the problems were caused by improper maintenance of the approved drainage control facilities or by not following approved drainage control plans. The WVDEP records for 1995-99 were assembled and reviewed where citizens alleged flooding was caused by mining. A total of 126 complaints were investigated. Sixty-two (62) complaints were associated with surface coal mine sites. Eight (8) of these investigations resulted in enforcement actions being taken to require corrections to drainage control structures. The KYDSMRE flooding complaint records for 1996-99 were also reviewed. Thirty-five (35) investigations resulted in 5 enforcement actions to require corrections to drainage control structures. The VADMLR flooding complaint records for 1995-99 showed 3 complaints investigated for surface coal mining sites. None of the investigations resulted in enforcement actions.

e. Other Studies

Two other flooding-related studies were completed in the EIS study area. The areas evaluated in these studies were in Kentucky and West Virginia. The Kentucky study, "Joint OSM-DSMRE Special Study Report On Drainage Control" was completed in December, 1999. The West Virginia study, "Runoff Analysis of Seng, Scrabble, and Sycamore Creeks" was completed in June, 2002. The studies were designed to determine whether mining caused increases in "peak flow" downstream from the mine sites and if so, the extent to which peak flows were increased. It should be noted that the West Virginia study also evaluated the impacts of logging on peak flows. In general, these two studies concluded that mining does influence the degree of runoff, but that the extent to which a change in runoff may have actually caused or contributed to flooding were site-specific. Site-specific factors may include topographic influences, stream channel conditions, distance downstream from the mine site, man-made channel restrictions, etc. The complete state studies, including conclusions and recommendations, are found in Appendix H.

Both states' studies recognized the need for the proper, thorough analysis of peak flow and flooding potential. Kentucky's mine regulatory agency has implemented a policy requiring that certain specific engineering considerations be evaluated when conducting a review of a proposed mine application. The policy has been included in Appendix K. West Virginia is evaluating their study conclusions and recommendations and considering regulations that would require peak flow analysis and other measures to minimize flooding potential downstream of mine sites and logging operations.

H. RELATIONSHIP OF MOUNTAINTOP MINING TO GROUNDWATER QUALITY AND QUANTITY

1. EIS Workshop Findings

Some public comments received during the EIS Scoping Process centered on the impacts from Mountaintop Mining/Valley Fill (MTM/VF) to the groundwater system. Principal among these were immediate and long-term changes to groundwater quality and quantity due to MTM/VF mining practices. Blasting effects to private water supplies and groundwater quality in general were concerns, as was migration of other contaminants from mine sites. In contrast, one comment expressed a belief that valley fills maintained baseflow during low flow periods by providing a more reliable groundwater reservoir.

In support of this EIS, the Workshop on Mountaintop Mining Effects on Groundwater was held in Charleston, West Virginia on May 9, 2000. The purposes of this workshop were as follows:

1. Identify potential impacts from mountaintop mining with valley fills on groundwater quality and quantity,
2. Review existing literature and current research studies focused on the effects from mountaintop mining on groundwater systems.
3. Review and assess public comments concerning mountaintop mining impacts on groundwater received during the EIS Scoping Process and,
4. In light of the recent workshop, identify potential technical and policy actions to be considered during the EIS process.

This section summarizes the results of this workshop and other available studies on the effects of MTM/VF mining on groundwater in relation to public concerns. A conceptual model of groundwater flow is examined and potential impacts from MTM/VF are explained. Note that blasting effects are discussed separately in Section III.

2. Pre-mining Appalachian Groundwater Flow System

The surficial geology of the Appalachian coal basin is dominated by layered sedimentary sequences of Mississippian and Pennsylvanian ages. These rocks encompass cyclic sequences of lithology that document the rise and fall of sea level and basin subsidence due to compaction and plate tectonics. These sequences are called cyclothem sequences and typically repeat themselves in 15 to 50 meter intervals. They emanate from changing energy conditions in the depositional environment resulting in stratigraphic facies changes (Brady et al, 1998).

Facies/lithological changes produce the layered rock sequence seen in Appalachian drill holes and road cuts. Cyclothem sequences show repeated sandstone, shale, limestone and coal lithology that vary laterally and vertically. The impacts of cyclothem sequences on the groundwater flow system are evident in the heterogeneous nature of the hydraulic properties found throughout this region.

Cyclothem sequences affect the permeability of the aquifer matrix by influencing the hydraulic conductivity and transmissivity properties of the aquifer matrix. Permeability refers to the water transmitting properties of an aquifer unit and has two components: primary and secondary. Primary rock permeability refers to the interstitial openings between rock grains and is controlled by rock porosity. Secondary permeability refers to any form of fracture, bedding plane separation, or solution channel that occurs after sediment consolidation. Hydraulic conductivity refers to the ability of geologic strata to transmit water. Transmissivity is a related term and is calculated by multiplying the hydraulic conductivity by the saturated thickness to arrive at the total water transmitting capacity of an aquifer unit. Transmissivity embodies the ability of the unit to transmit water and the area through which it flows. As a result of cyclothem sequences, permeability varies in three dimensions, producing very heterogeneous flow systems. Aquifer testing in this region indicates a wide range of spatial attributes in hydraulic properties, often times within the same stratigraphic interval (Bruhn, 1986, USGS, 1991, Minns, 1993, Minns et al, 1995). These same studies indicate hydraulic conductivity declines with increasing depth due to changes in consolidation of the overburden. In the Appalachian basin, secondary permeability is the dominant pathway for fluid movement (USGS, 1981, USGS, 1991). The combined affect of stratigraphic changes and differing fracture density has been shown to produce lateral changes in the hydraulic properties of aquifer materials (Stoner, 1987, Minns, 1993).

An interconnected stress relief fracture network of varying density underlies the Appalachian basin. Ferguson (1967) was the first to propose a model of stress relief fracture systems in the Appalachian basin. His model indicated arching of the strata underlying valleys due to overburden unloading associated with major stream valley development. Ferguson's model shows horizontal fractures underlying stream valleys with vertical fractures along the valley walls and ridge tops. Hill (1988) proposed a distinction between wide stream valleys (> 500 ft) and narrow, V-shaped stream valleys whereby the valley floor experienced compressive stress instead of tensile stress found in broader valleys. This phenomena results in a decrease in fracture density under V-shaped valleys. Since the work of Ferguson, several researchers have proposed general models of groundwater movement for this region that incorporate the valley stress relief concept (Hobba, 1981, USGS, 1981, Kip et al, 1983, USGS, 1985). Several studies also indicate that the majority of groundwater flow occurs in the top 250 to 300 feet of strata (Stoner, 1987, USGS, 1991, USGS, 2001). Researchers have characterized Appalachian basin aquifer systems as fracture flow systems with numerous perched aquifers in the upper topographic intervals (Hobba, 1981, USGS, 1991, USGS, 1991a, Kipp and Dinger, 1991, Minns, 1993). Groundwater availability is limited on hilltops due to reduced areal recharge potential, depth to water and reduced transmissivity values (Stoner, 1987, Kipp and Dinger, 1991, Minns, 1993).

3. Impacts to Groundwater Quantity from MTM/VF

Mountaintop removal is a surface mining technique that removes a series of coal seams by removing all overlying strata down to an economical limit governed by the overburden to coal ratio. Contour and area mining of mountaintops removes part of the coal seams in the mountain or all of the coal seam in portions (e.g., in a narrow ridge) of the mountain—also to the economic limits of extraction. Auger mining conducted from the contour or area mining bench may remove additional coal within the mountain. As these types of mountaintop mining operations progress, overburden in excess of that required to reclaim the mine site is placed in an adjoining valley(s). The SMCRA regulations stipulate that overburden placed in valley fills must meet certain engineering criteria to ensure stability, drainage control and reclamation/re-vegetation of the valley fill. In addition, each respective state permitting program ensures any discharge from the individual mining permits adhere to water quality standards as set forth under the various state and federal programs. The current EIS is an evaluation of the practices currently employed for MTM/VF techniques.

a. Conceptual Model of MTM / VF

Conceptually, MTM/VF mining is the complete or partial removal of mountaintops by breaking the strata into small blocks and placing the excess spoil in an adjoining valley. The physical effects of MTM/VF are clear; mountain slopes are radically decreased, both by removal of material and by filling adjoining valleys. The affects to the physical groundwater system are the elimination of the perched aquifer system in the mountaintops, and formation of an aquifer system in the valley fill.

The shallow, pre-mining perched flow system proposed by several researchers is located within the overburden strata associated with mountaintop topography (Hobba, 1981, USGS, 1991, Minns, 1993). This flow system forms the headwater areas of the region's streams and is a minor source of residential water throughout the Appalachian region due to the concentration of the majority of the population in stream valley settings. Removal of mountaintop strata removes the perched aquifer system and places the excess overburden in adjoining valleys, thus eliminating the perched system.

The placing of overburden in adjacent valleys of the MTM/VF regions of the Appalachian basin join two aquifer systems: the premining fracture flow system that underlies and adjoins the valley fill; and a postmining man made aquifer consisting of excess overburden removed during mining. Wunsch et al (1996) proposed a model of groundwater flow through a valley fill in eastern Kentucky. They determined water moved through the Star Fire mine site at differing velocities depending on the nature of spoil, preferential sorting of the spoil upon placement and degree of compaction during placement. This work corroborates work done by Carruccio et al (1984), Aljoe and Hawkins (1992), and Aljoe (1994) using pump tests and dye tracing in reclaimed surface mines. The change in spoil porosity affects the hydraulic conductivity distribution in the fill and ultimately dictates the groundwater flow regime that establishes within the fill. Groundwater gradients within the fill roughly follow the undisturbed topographic elevations; flowing along the pre-fill valleys. The type of fill material placed in these locations enhances this flow mechanism (Aljoe, 1994). Wunsch, et al (1996) noted at the Star Fire site that water recharges the site by way of surface water infiltration along the highwalls, groundwater infiltration through the highwalls, chimney drains placed in the fill, and along the headwater areas of stream courses covered during the operation. At the Star Fire site, groundwater discharges as spring flow at the toe of fill, into an adjacent active dragline pit, and into sediment ponds located on lower portions of the fill. The sediment ponds are used for dust suppression and are pumped on a continuous basis. The Star Fire site is a typical valley fill scenario.

b. MTM/VF impacts to the physical Ground Water system

Valley fills create aquifer systems that perform two functions: 1) store a larger percentage of water that would normally run off the landscape; 2) serve as separate aquifer systems. Overburden placed in valley fills consists of broken strata that are disposed of in an adjacent valley. These fills are large-scale, generally primary porosity-driven flow systems although some studies have indicated a dual porosity flow system (Caruccio, 1984, Aljoe, 1994). Water moves through them under hydraulic gradients (i) derived from the hydraulic conductivity (K) and storage (S) properties of the rock fragments. The storage (storativity) properties of the man-made aquifer are significantly greater than the original rock mass due to the increase in pore space. Total porosity may be similar between pre and post-mining scenarios but increases in pore size and connectedness create greater *effective* porosities allowing more water to freely move through the aquifer unit. Effective porosity values for undisturbed Appalachian fractured rock aquifers range from 0.001% to 0.1% (MacKay and Cherry, 1989). Brown and Parizek (1971) found laboratory-measured porosities of coal bearing strata to range from 0.8% to 9.4% with a mean of 3.9%. Several authors have found insitu effective porosities in surface mine spoil ranging from 14% to 36% spoil aquifers (Cederstrom, 1971, Wells, et al, 1982, Hawkins, 1995). Using the laboratory derived effective porosity for insitu strata of 3.9% and an average effective porosity of spoil of 25% equates to an approximate 21% gain in porosity over premining values. A 1000-acre unmined site with a 30 foot saturated thickness stores approximately 12 million gallons of water at 3.9 % porosity, while the same size valley fill stores approximately 81 million gallons of water at 25% porosity. The valley fill site holds approximately 7 times more water than its premining counterpart.

The increase in storage of valley fill aquifers is also enhanced by a decrease in runoff volumes associated with slope reduction. Simple runoff calculations using Natural Resource Conservation Service techniques indicate runoff volumes theoretically decrease by approximately 50% for a reduction in slope from steep (i > 8%) to flat (i = 0 to 3%) classifications and allowing the CN value (CN 70 to CN 75) to increase to account for decreased vegetation (Maidment, 1993). This decrease in runoff theoretically allows more water to infiltrate and/or re-saturate the surface of the valley fill. By diverting the runoff into the valley fill, water is effectively stored in the fill material and is released in a more subdued manner, thus affecting the peak flow volumes in adjacent streams. Wunsch et al (1996) and Wiley et al (2001) noted this phenomenon in their Appalachian basin fieldwork. Research by the USGS on stream flow characteristics in the Appalachian basin indicates similar trends (Paybins et al, 2002, Messinger, 2002).

Data from the Star Fire site indicate a greater percentage of precipitation is captured by the valley fill aquifer system compared to unmined settings. A flume located immediately downstream of the valley fill captures all the water leaving the site as discharge from the various groundwater discharge points. Measurements taken during normal baseflow conditions, that eliminate the influence of surface water, indicate 1000 gallons of water per minute (2.23 cfs) is discharging from the Star Fire site. The site has an approximate area of 1000 acres resulting in an effective infiltration rate through the valley fill of approximately 1.0 gallon per minute per acre (gpm/acre). Assuming 49.7 inches of rainfall per year, 1.35×10^6 gal/year of precipitation falls on this part of Kentucky. This total equates to 2.57 gal/min of rainfall per acre of land surface. The Star Fire site discharges approximately 1.0 gal/min/acre of valley fill, equating to 39% or 19.3 inches of the yearly precipitation falling on the land surface. Typical unmined Appalachian basin mean groundwater discharge rates range from 6.7 to 31.6 inches per year (18.8% to 50.9%) measured as the groundwater discharge component of stream baseflow in West Virginia, Virginia, and North Carolina (USGS, 1996, USGS, 2001, USGS, 2001). USGS (2001) report a band of the high mean infiltration rates (41.1% and 50.9% of total precipitation) located in a narrow band encompassing the eastern portions of West Virginia. The majority of infiltration rates cited by USGS (2001) range between 18.8% and 27.1% for the remainder of West Virginia based on 27 different stream stations. At a 39% infiltration rate, the Star Fire site directs a larger proportion of precipitation into the valley fill than is implied in recent research in unmined scenarios.

Insitu infiltration rates determined by infiltrometer studies performed on contour surface mines also indicate spoil infiltration rates increase through time; ameliorating the affects of compaction on the surface (Jorgenson and Gardner, 1987, Ritter and Gardner, 1993). Ritter and Gardner (1993) showed through modeling, that hydrograph curves evolved over time to closely mimic runoff curves associated with saturation overland flow processes. They also concluded that runoff processes at surface mined sites are dominated by saturation overland flow which cause decreased peak runoff and increased time to peak runoff that result from the lagged response of return flow to the surface water network. Recent field studies on the effects of valley fills on peak stream discharge indicate similar trends and responses to their modeling research (Messinger, 2002).

Increases in effective porosities of spoil also lead to increases in hydraulic conductivity. Hawkins (1995) found spoil conductivities were 1 to 2.5 orders of magnitude greater than the adjacent rock mass. Herring (1977) and Weiss and Razem (1984) also noted similar findings in spoil related research. Aljoe (1994) noted that increases in the percentage of sandstone overburden in a fill also increase porosity and hydraulic conductivity. The increase in hydraulic conductivity and storativity leads to increased water velocity and reduced hydraulic head in the postmining spoil aquifer (Hawkins, 1995). The reduction in hydraulic head is related to the decrease in hydraulic energy required to drive water through spoil aquifers compared to undisturbed strata. Booth and Spande (1992) and Kendorski (1994) noted similar overburden aquifer response in longwall mining areas due to a similar increase in hydraulic conductivity and storativity.

Interaction between spoil aquifer systems and the underlying aquifer system is likely limited in areas compacted by mining equipment during active mining phases. In these areas, compaction has reduced infiltration capacity by providing an effective low permeability confining layer separating the underlying flow system from the valley fill. Wunsch et al (1996) found similar responses to rainfall runoff in areas of compacted cover material for a valley fill area in eastern Kentucky. Hawkins (Brady et al, eds., 1999) also points out similar phenomena in his chapter on hydrogeologic characteristics of surface mine spoil.

c. Impacts to Valley-bottom Groundwater Recharge From MTM/VF

Groundwater recharge to lower elevations may be impacted by mountaintop removal by reducing the amount of recharge available and/or diverting groundwater to the valley fill flow system. However, conceptual models of premining groundwater flow indicate the amount of water actually recharging valley aquifers may be limited and as such MTM/VF impacts on these aquifers would likely be similarly limited. A large percentage of precipitation falling on upland areas runs off, becoming surface flow in streams. Water that does infiltrate may or may not become part of the deeper groundwater system dependent upon existence and/or interception by valley sidewall fractures. Water that is not diverted vertically will flow horizontally on top of low permeability strata and emanate as spring flow on the valley sidewalls. Water that does get diverted into the valley sidewall fracture system infiltrates and becomes part of deeper flow systems. This water may be capable of providing a component of recharge to valley bottom aquifers. Further research needs conducted to determine the impacts from diversion / elimination of these perched systems to lower elevation alluvial aquifer systems.

4. Impacts to Groundwater Chemistry From MTM/VF

SMCRA mandates that all coal mining operations collect quarterly sampling for total iron, total manganese, total suspended solids and pH. These minimum parameters are collected at all approved mining related discharge sites and monitor the most significant components of typical coalmine drainage. The minimum list does not capture the entire expected range of chemical species emanating from coal mine drainage.

In its most basic form, overburden containing silicate and carbonate minerals is broken up, deposited into an adjacent valley, and water is allowed to flow through the fill material. The exposure of fresh mineral surfaces to a geochemically reactive material (water) produces the water chemistry produced at coal mine sites.

a. Geochemical Reactions

Coal mine drainage is produced by the oxidation of pyrite in an aqueous environment that dissociates the iron and sulfur found in the pyrite (FeS_2). Pyrite is a sulfide mineral commonly formed in the reducing environments associated with Bituminous coal fields. Coal mining and subsequent overburden removal exposes the pyrite to oxygen, which is summarized by the following reaction (1) (Brady et al, 1999):

$$FeS_2\,(s) + 3.75\ O_2 + 3.5\ H_2O = Fe(OH)_3(s) + 2\ SO_4^{2-} + 4\ H^+ + heat \quad (1)$$

Alkaline mine drainage can be produced when acidic mine water comes in contact with alkaline overburden and/or alkaline recharge migrates into the valley fill. The reaction (2) between pyrite, calcite, in limestone, and water is:

$$FeS_2 + 4\ CaCO_3 + 3.75\ O_2 + 3.5\ H_2O = Fe(OH)_3 + 2\ SO_4^{2-} + 4\ Ca^{2+} + 4\ HCO_3^- \quad (2)$$

This reaction will produce alkaline mine drainage with circumneutral pH, alkalinity greater than acidity, high sulfate and calcium concentrations and iron hydroxide as a precipitate.

Researchers have also noted high levels of sodium, magnesium, and calcium in coal mine drainage that were attributed to cation exchange (Winters et al, 2000, Perry, 2001). Divalent calcium and magnesium ions are exchanged at surface sites of clay minerals for monovalent sodium ions and can be summarized by the following reaction:

$$2\ Na^+\ \_\ 1\ Ca^{2+}\ (Mg^{2+})$$

Preliminary research by the EPA for the EIS document also indicates increased levels of selenium in bituminous basin discharge water (USEPA, 2002). Aluminum has also been documented in coal mine drainage at elevated levels (Brady et al, 1999).

No correlation was possible in an EPA statistical evaluation ("Ecological Assessment of Streams in the Coal Mining Region of West Virginia Using Data Collected by the U.S. EPA and Environmental Consulting Firms") of the amount and age of upstream disturbance on the character of water quality impacts; or the distance downstream that the mineralization persisted (USEPA, 2002). Further study is needed to determine the duration of the mineralization, which may be expected to decrease with time as backfill and valley fills are "flushed" of soluble materials.

b. Conceptual Geochemical Model

Overburden mineralogy determines the final geochemical signature of post mining water quality. Mining exposes fresh rock surfaces to water and oxygen allowing several reactions to occur, most notably pyrite oxidation, calcite dissolution and cation exchange. Silicate weathering may also provide chemical constituents to the final mine water chemistry, especially in acidic discharges.

Relationships between overburden mineralogy and groundwater composition lead to ionic dominance of various chemical constituents found in a water sample. Piper tri-linear diagrams provide a visual representation of the composition of the major constituents found in a water sample. Relative compositions of calcium, magnesium, sulfate, bicarbonate and chloride ions are plotted on triangular axes from which mineral provenance is estimated based on a comparison between discharge chemistry and the mineralogical composition of the aquifer matrix.

Geochemical modeling of Appalachian basin groundwater indicates several different geochemical facies are present in pre-mining aquifers. Geochemical sampling of pre-mine groundwater indicates three distinct geochemical zones within the aquifer system of the Appalachian basin. The deepest zone is characterized by sodium and chloride ions associated with brine water at depth (Rose and Dresel, 1990). Numerous studies indicate a brine – fresh water interface at depths of 1000 feet below surface with upconing under major stream valleys to depths of 100 feet (Stoner et al, 1987, Minns, 1995). The upconing area is a mixing zone but contains considerable quantities of sodium and chloride ions diluted by mixing with shallower water types. Intermediate geochemical zones are characterized by removal of the chloride ion by flushing, resulting in a sodium–bicarbonate ion dominated water chemistry. Wunsch (1993) and Minns (1995) geochemical models show this water signature was found at depths ranging from 50 to 150 feet below local base level. Shallow flow systems are dominated by calcium–bicarbonate ions due to flushing of the sodium ions from the system. Brady et al (1996) further subdivided this shallow zone into a low total dissolved solids (TDS) zone associated with stress relief/weathered regolith and a higher TDS zone associated with ridge cores. The difference between the two sub-systems is derived from water residence time and degree of weathering between the two sub-systems. Longer residence times in contact with unweathered material produces more ions in the water leading to higher TDS values whereas shorter residence time with weathered material leads to lower TDS values. Wunsch (1993) and Minns (1995) found similar geochemical zones but also found sulfate and magnesium were present in significant quantities in these shallow geochemical zones.

In Kentucky valley fills, Wunsch et al (1996) found that water emanating from the fills was a calcium–magnesium–sulfate type water resulting from pyrite oxidation and calcite dissolution along the groundwater flow path. Discharge data from Wunsch et al (1996) supports neutralization of pyrite oxidation products within the valley fill interior. Pyrite oxidation is likely occurring within the unsaturated portion of the fill as evidenced by the elevated sulfate (range: 300 to 2000 mg/l) concentrations in the discharge water quality. These oxidation products (Fe, SO^4) are then carried with infiltration and/or groundwater to the main flow paths through the fill. Alkalinity generating processes are also at work buffering the pH to approximately 6.2 (except well 14). The discharge chemistry contains significant concentrations of neutralization products (Ca, Mg, HCO^3) leading to the calcium–magnesium–sulfate type water emanating from the Star Fire site. This conceptual flow model has been observed at surface mines throughout the Appalachian basin (USGS, 1990).

The Star Fire site also indicated increased concentrations of total dissolved solids in the discharge chemistry. This phenomena results from the release of ions due to exposure of unweathered minerals placed in the fill as spoil. Elevated TDS concentrations have been documented in surface mining discharge chemistry for more than 25 years (USGS, 1983, Quinones et al, 1981).

In the absence of neutralization materials, acidic discharges can develop whereby the main ionic constituents are iron and sulfate with lesser amounts of aluminum and manganese resulting in a sulfate–iron dominated type water. This water will have low pH (< 5.0) and very high TDS concentrations (> 2000 mg/l). This water can also be very reactive with overburden mineralogy: dissolving silicate minerals producing significant concentrations of dissolved silica, aluminum, magnesium and trace metals.

5. Summary of Groundwater Impacts

Mountaintop mining removes the perched aquifer system from the base of the target coal seam upwards. By placing this material into the adjacent valley, a new aquifer is formed. The valley fill aquifer system develops according to the physical properties of the spoil matrix and corresponding flow mechanisms that develop. Overburden placement techniques, material sorting and post-deposition compaction control the hydraulic conductivity and corresponding hydraulic gradient distribution within the valley fill. The valley fill is also capable of storing larger volumes of water compared to the original rock mass. These storage components affect stream hydrology by creating lag times in storm-induced runoff hydrographs. Sedimentary rock overburden mineralogy controls the discharge chemistry in the Appalachian basin. Exposure of fresh mineral surfaces to oxygen and water provide the geochemical mechanism for chemical evolution within the fill. The ultimate expression of the discharge is controlled by the amount and residence time of the water within the fill, which are governed by the physical properties of the spoil matrix. The Star Fire site in eastern Kentucky is a good conceptual model of an average valley fill aquifer system found in the Appalachian basin. It represents typical overburden mineralogy, mining technique and discharge chemistry of a typical Appalachian coal basin mountaintop mine.

EPA, in a 2002 statistical study of stream quality and macroinvertebrates mountaintop mine sites found correlations of stream impairment with mining disturbances upstream (USEPA, 2002). However, their report found certain data gaps for which no correlations could be evaluated. The study recommended additional evaluation to determine:

- The duration of mineralization of groundwater discharges from mountaintop mining sites. Improvements in water chemistry may be expected, with time, as the backfills and valley fills are flushed of soluble minerals on the fresh rock surfaces.
- The correlation of the size of mining disturbance and associated “mining aquifers” in a watershed with the amount of mineralization. That is, do larger backfill and valley fills increase mineralization beyond that occurring for smaller fills?

6. Groundwater Quantity and Quality Conclusions

Removal of the pre-mining perched aquifer system and associated valley fill will impact the headwater reaches of first order streams in the region by eliminating streams. Impacts to valley bottom aquifer may or may not occur depending on density of valley sidewall fractures.

Creation of valley fill aquifers change the hydrology of streams receiving baseflow from valley fill aquifers by diverting a greater percentage of precipitation into the fill, allowing water to be released at a much slower and less intense rate compared to normal storm-induced stream hydrographs (Ritter and Gardner, 1993, Wiley, 2001, Messinger, 2002).

Groundwater chemistry within valley fills changes from $Ca–HCO_3$ dominated water to a $Ca–Mg–SO_4$ dominated water reflecting pyrite oxidation and neutralization of oxidation products in the fill interior (USGS, 1990, Wunsch, et al, 1996).

MTM/VF water chemistry indicates increases in TDS resulting from groundwater contact with unweathered overburden fill material.

Further Study: Impact of MTM/VF on alluvial aquifer systems; interaction between valley fill and adjacent aquifer systems; sources of selenium in MTM/VF regions; geochemical effects from weakly buffered overburden in valley fills; correlation of mineralization characteristics with specific stratigraphic horizons, size and age of disturbance; and the duration of mineralization and distance of effects downstream.

I. OVERVIEW OF APPALACHIAN REGION COAL MINING METHODS

Mining has been conducted in the Appalachian coalfields since European settlers arrived in the region in the 1700s. Uses of coal have progressed from simple home heating and cooking, to fuel for railroads and steamships and industrial processes, and now to a predominant share of the electric power generation market. To keep pace with increasing demand, methods of mining coal have advanced from pick-and-shovel works to steam-powered equipment and now to mechanized deep mines and large-scale surface operations. National industry trends have favored surface operations over underground mining in recent decades, driven by the advent of very large earthmoving equipment, and surface methods now account for the majority of nationwide production. This trend is expected to continue, as surface mines generally provide better coal recovery than underground mines and have lower overall production costs per ton of coal.

UNDERGROUND MINING DOMINATES COAL PRODUCTION IN THE STUDY AREA

In Kentucky, Tennessee, Virginia, and West Virginia, underground mining still dominates coal production, comprising 61 percent of the combined production for the study area in 1998, while surface mining methods account for the rest (EIA, 2000). A significant percentage of these surface mines can be categorized as Mountaintop Mining/Valley Fill (MTM/VF) operations, and use of this mining method has become widespread in recent decades in response to increasing competition from western coal producers. MTM/VF operations are generally the most economical and efficient forms of surface mining in steep-slope Appalachia and provide for the highest possible recovery of multiple coal seams.

The term "mountaintop mining" used in the EIS encompasses three different kinds of surface mining operations (contour mining, area mining, and mountaintop removal mining) that create valley fills. This is a broader definition than the legal definition used in SMCRA "mountaintop removal mining." Mountaintop removal mining totally extracts underlying coal seams, and the reclaimed land is left in a flat or gently rolling configuration capable of supporting certain post-mining land uses, such as industrial, commercial, residential, agricultural, or public facilities (including recreational facilities). Since the reclamation of a mountaintop removal mine will leave flat or gently rolling land, the "approximate original contour" (AOC) standard of SMCRA does not apply. This is also true of steep slope AOC variances allowed under SMCRA-which may occur at area or contour mines. Thus, the reclamation required of a mountaintop removal or AOC variance mine is markedly different from that of an AOC steep slope area or AOC contour surface coal mine. Steep slope AOC variances and mountaintop removal operations, by their very nature, result in greater excess spoil disposal. This EIS will use the broader terms "mountaintop mining" or "mountaintop operations" to refer to all of these types of surface coal mining in the steep slope areas of the central Appalachian mountains.

Because of significant differences and much variability in geology, topography, and property ownership patterns, surface mining practices can vary from state to state within the Appalachian coal fields. For example, significant "overburden to coal" ratios often restrict the Kentucky mining industry to two or three coal seams that can be economically extracted by mountaintop mining methods. As a result, the typical surface coal mine in Appalachian coal fields of Kentucky is approximately 350 - 400 acres in size. In West Virginia, as many as 18 seams might be mined in some permits of more than 1000 acres. In Virginia, the permit sizes are typically smaller than West Virginia and Kentucky mines, and coal removal may be limited to 3-5 seams.

Because there are a very large number of small surface owners in the eastern Kentucky coal fields, acquisition of consent to entry for the purpose of mining is often a very expensive, difficult, and very time-consuming process. This land ownership pattern is quite different than that found in adjacent coal producing states, and also serves to greatly limit both the permit size and the scale of mining conducted by the Kentucky coal mining industry.

Surface coal mining operations in Virginia differ significantly from surface coal mining operations in West Virginia and differ somewhat from those operations in Kentucky. Surface coal mining in Virginia has a long history, with most of the actively-producing coal region affected by pre-SMCRA strip mining activities. Almost all of the permit applications received by VADMLR contain AML areas that total between 50 % and 80 % of the area. Most of the streams on these proposed mine sites have been impacted by pre-SMCRA mining, and may be impacted by old spoil and/or dislocated by the prior mining. Often streams shown on the USGS topographic maps no longer exist or may have been moved by placement of spoil into the stream. Often there are long segments of stream that have no defined stream channel: the stream may spread into a wetland, it may disappear under spoil, or it may have been affected in other ways by the pre-SMCRA mining activities that occurred in the vicinity.

The size of mining operations in Virginia is limited by several factors. These include factors such as geologic conditions, steep slopes, and fragmented mineral and surface property ownership. The remaining reserves are also fragmented by prior AML and underground mining operations creating relatively small non-contiguous areas of coal available to be mined. Proposed permit areas usually consist of second cut areas that are separated by AML highwalls that cannot be mined due to prior augering, the proximity of underground mining, or excessive ratios of overburden to coal. Companies in Virginia often mine ratios exceeding 20:1 in order to recover what coal is available. These AML benches and highwalls that are not mined are used to dispose of excess spoil generated by the adjacent remining operations. There are a few permits that have first cut areas proposed, but these are usually limited in extent and are adjacent to second cut areas. VADMLR requires companies to minimize valley fills by using the excess spoil to reclaim adjacent AML highwalls and benches. Virginia mining operations reclaim nearly all areas to AOC. There are no drag lines operating in Virginia.

Current technology achieves nearly the highest possible recovery of the coal reserves beneath a typical tract of Appalachian land; however, this is neither always economically feasible nor acceptable from an environmental standpoint. Modern coal mining combines a variety of approaches to coal extraction that reflect the maximum amount of coal that can be recovered from a given land parcel within current market conditions and the regulations that govern coal mining. The two basic approaches are underground mining, where the coal is extracted without removing the overlying soils and rock, and surface mining, where this material, known as *overburden*, is removed to expose the coal for extraction.

In this section, Appalachian coal mining methods are first reviewed to provide background for further discussion. Typical mountaintop mine complexes are then described. The typical characteristics of MTM/VF operations are presented to summarize this composite mining practice in section III.J. Section III.L presents a review of the factors influencing the feasibility of coal mining on a given site and the typical approach to developing a mine plan.

1. Underground Mining Methods

A description of underground mining methods is provided in the EIS as background to facilitate the discussion of whether underground mining methods would be able to take the place of surface mining methods. This section also provides background to the description of the synergism between underground and surface mining methods for purposes of blending coal. In underground mining, also known as *deep mining*, coal is extracted by excavating within the horizon of a coal seam and without removing the overlying overburden for reasons other than primary seam access. This approach is practical for seams of greater than 100 feet in depth, as underground mining of shallower seams can encounter difficulties with roof integrity and surface cracking (Suboleski, 1999a). Underground mines can be categorized by the manner in which access to a coal seam is made, and by the manner in which a coal seam is extracted. Access methods can include drift, slope, and shaft mines, and extraction methods can include room and pillar (conventional and continuous) and longwall mining. The method of coal extraction is not dependent on the method of access, and multiple methods of access and extraction may be present in an individual mine. Although not directly related to the focus of this EIS on surface mining valley fill impacts, underground mines are part of the overall coal industry within the study area, representing at times a constraint on the extent of surface mining or an alternative to surface mining.

a. Underground Mine Access

The method of accessing a coal seam for underground mining depends largely on its vertical position relative to the ground surface. The three basic options are summarized by Figure III.I-1. A *drift* mine enters a coal seam horizontally, requiring that the access be where the coal outcrops on the side of a slope or mountain. This is generally the simplest and most economical mine access method due to the fact that there is no significant excavation into the overburden. A slope mine utilizes an inclined entry to access the coal seam and is employed where the coal outcrop cannot be directly accessed, but is still within a reasonable vertical distance from the ground surface. Slope entries are usually driven at angles of less than 16^{o} from the horizontal, in order to facilitate conveyor haulage, and must tunnel through the rock above the coal, or overburden, to achieve this access (Suboleski, 1999b). A shaft mine consists of a vertical opening driven from the ground surface to the coal seam and is employed where the coal seam is relatively deep or cannot be otherwise accessed due to topography or property limitations. This elevator arrangement, known as a *hoist,* is used to transport coal and miners to and from the surface through the shaft, with coal carried in hoist cars known as *skips*, and miners riding in hoist cars known as *cages*. An individual mine may have more than one of these access types, depending on safety, coal haulage, ventilation, and supply requirements.

b. Room and Pillar Mining

The defining principle of a room and pillar mine is that portions of the coal seam remain in place to support the mine roof while coal is extracted. Room and pillar mines are developed by driving parallel series of *entries*, usually four to eight in a series, with perpendicular *crosscuts* that connect the entries to form a grid-like pattern in a panel of coal, which can be more than 400 feet wide and half a mile long. Figure III.I-2 shows an example of a typical room and pillar mining plan. The coal blocks that remain within this pattern after primary coal extraction are referred to as *pillars* or *stumps* and serve to support the roof of the mine. The coal pillars are generally 20 to 90 feet wide, and the entries average 20 to 30 feet wide. Room and pillar mines are best suited to relatively small reserves, or reserves where variable coal quality requires selective extraction within the seam, and can be applied to seams from 28 inches to 13 feet in thickness. The equipment required for room and pillar mining has a smaller capital investment requirement than that for a longwall mine and can be more easily moved to other mine sites (Suboleski, 1999a).

After a panel has been fully developed, the mining direction is usually reversed for retreat or secondary extraction. During secondary extraction, some of the remaining coal pillars are removed in a systematic manner in order to maximize the amount of the coal seam that is recovered from the panel. Secondary extraction can result in roof collapse and subsidence as the roof support of the pillars is removed. The amount of secondary mining performed at a mine depends on safety, subsidence, geology, and coal market considerations. Room and pillar mines with both primary and secondary extraction can achieve approximately 70 to 80 percent recovery of a coal seam, while primary extraction alone can achieve only about 40 to 60 percent (McDaniel & Kitts, 1999). Within this general mining type, the two basic extraction methods employed in room and pillar operations are conventional and continuous mining.

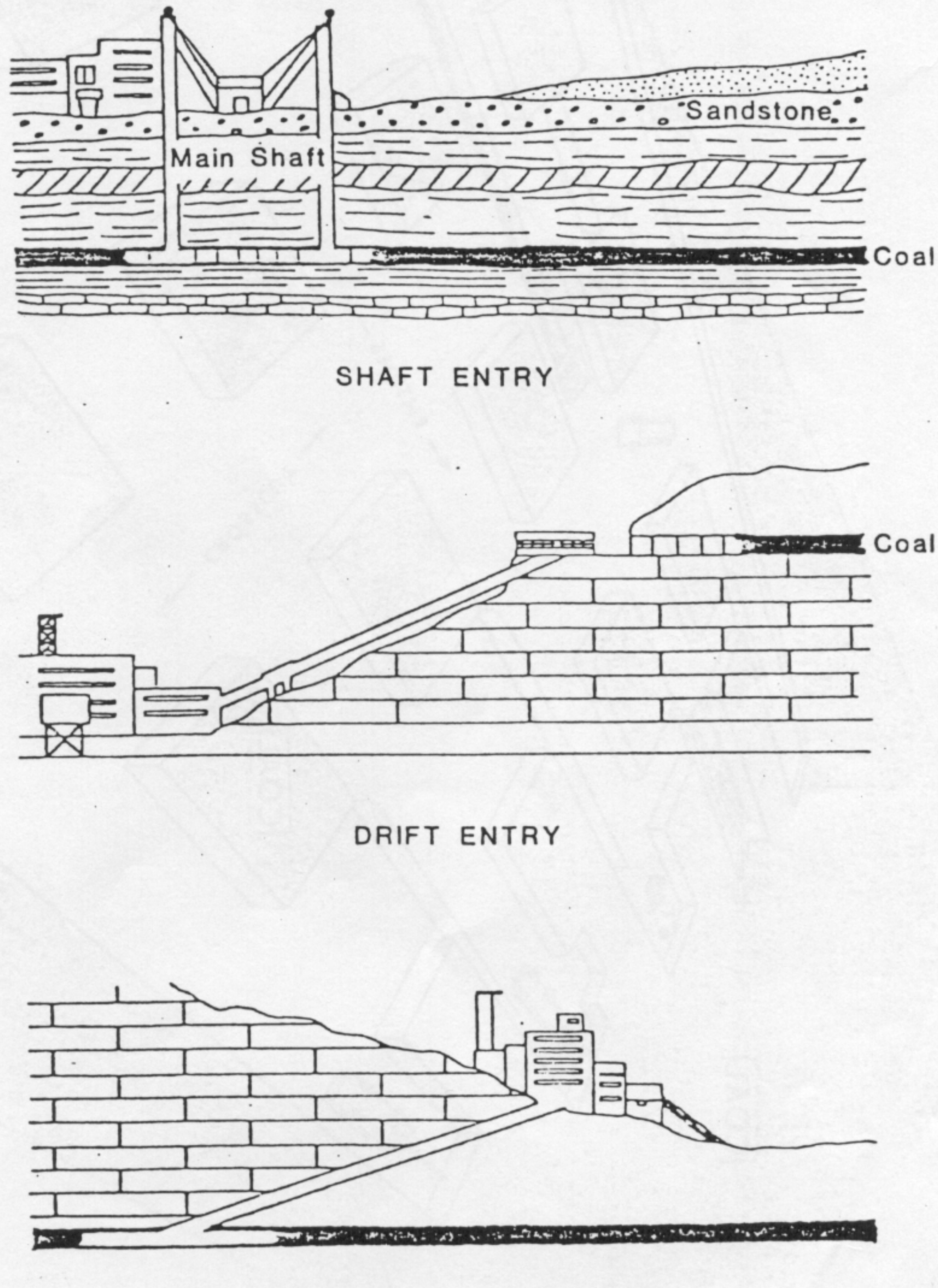
b.1. Conventional Room and Pillar Mining

Conventional room and pillar mining employs a combination of mechanical cutting machines and blasting to extract coal from coal faces exposed within an advancing panel. Once the predominant mining method in the Appalachian coal fields, it now accounts for only about 10 percent of total production (Suboleski, 1999b). The conventional process is conducted in five distinct steps:

1) Cutting – the coal face is undercut, side, center, or top cut by a mobile machine that resembles a large chain saw. Cutting of the coal allows another open face into which the rock can be blasted.
2) Drilling – the coal face is drilled in a pre-determined pattern to insert a blasting agent or compressed air.

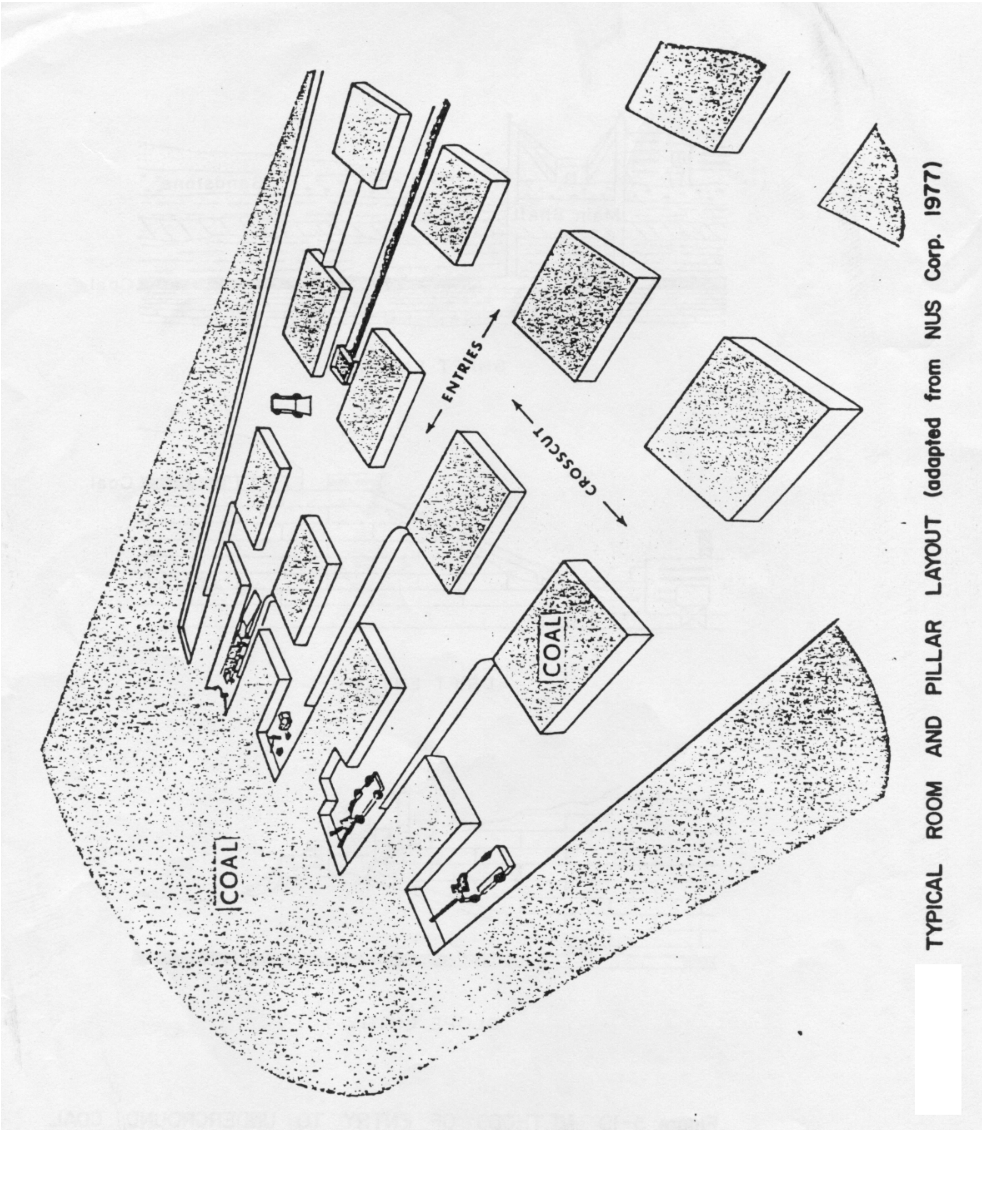
3) Blasting – the cut coal face is blasted to free the coal for loading and hauling.

Figure III.I-1
Basic Options for Underground Mine Access



METHODS OF ENTRY TO UNDERGROUND COAL MINES (adapted from Michael Baker 1975)

Figure III.I-2
Typical Room and Pillar Mine Plan



4) Loading and Hauling – the loose coal is transported to a belt conveyor or mine-car loading point and hauled out of the mine.

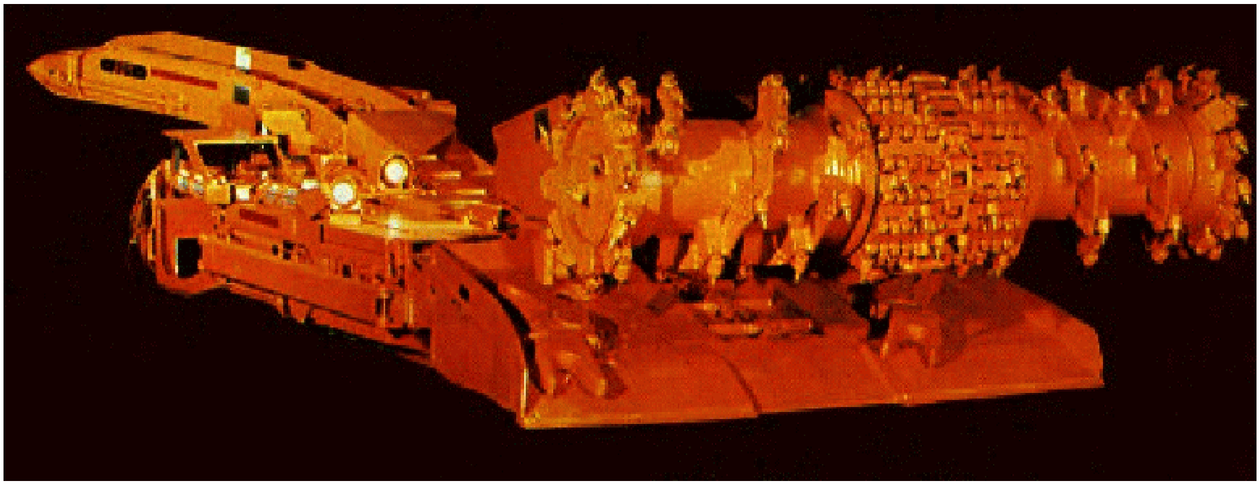
5) Roof Bolting and Advancement of Support Services – roof support is installed, ventilation is extended to the new working face, and supplies are brought in to develop the next set of entries and coal faces.

The conventional method is advantageous where the coal seam is irregular in thickness or quality, or if there is a parting (a layer of rock separating the seam) associated with the seam. The conventional method also allows for a certain amount of control over the product size, which is tied to the design of the blasting pattern.

b.2. Continuous Room and Pillar Mining

A more popular coal extraction technique of the room and pillar system is the continuous method, which utilizes a continuous mining machine to mechanically break the coal from the face and load it onto haulage equipment or belt conveyors. Figure III.I-3 shows a typical continuous mining machine, with cutting heads in the front and conveyor loader in the rear. When a cut into a coal face is completed, the continuous miner is removed from the face and roof support, usually roof bolts, is installed and ventilation is advanced. The continuous mining method has fewer operational steps than the conventional method, therefore reducing the number of required working faces in the coal seam. Continuous mining reduces manpower requirements, concentrates activity, and reduces support service problems. However, it is not as flexible for addressing variations in coal quality or the presence of partings.

Figure III.I-3
Typical Continuous Mining Machine



Modified from Suboleski, 1999a

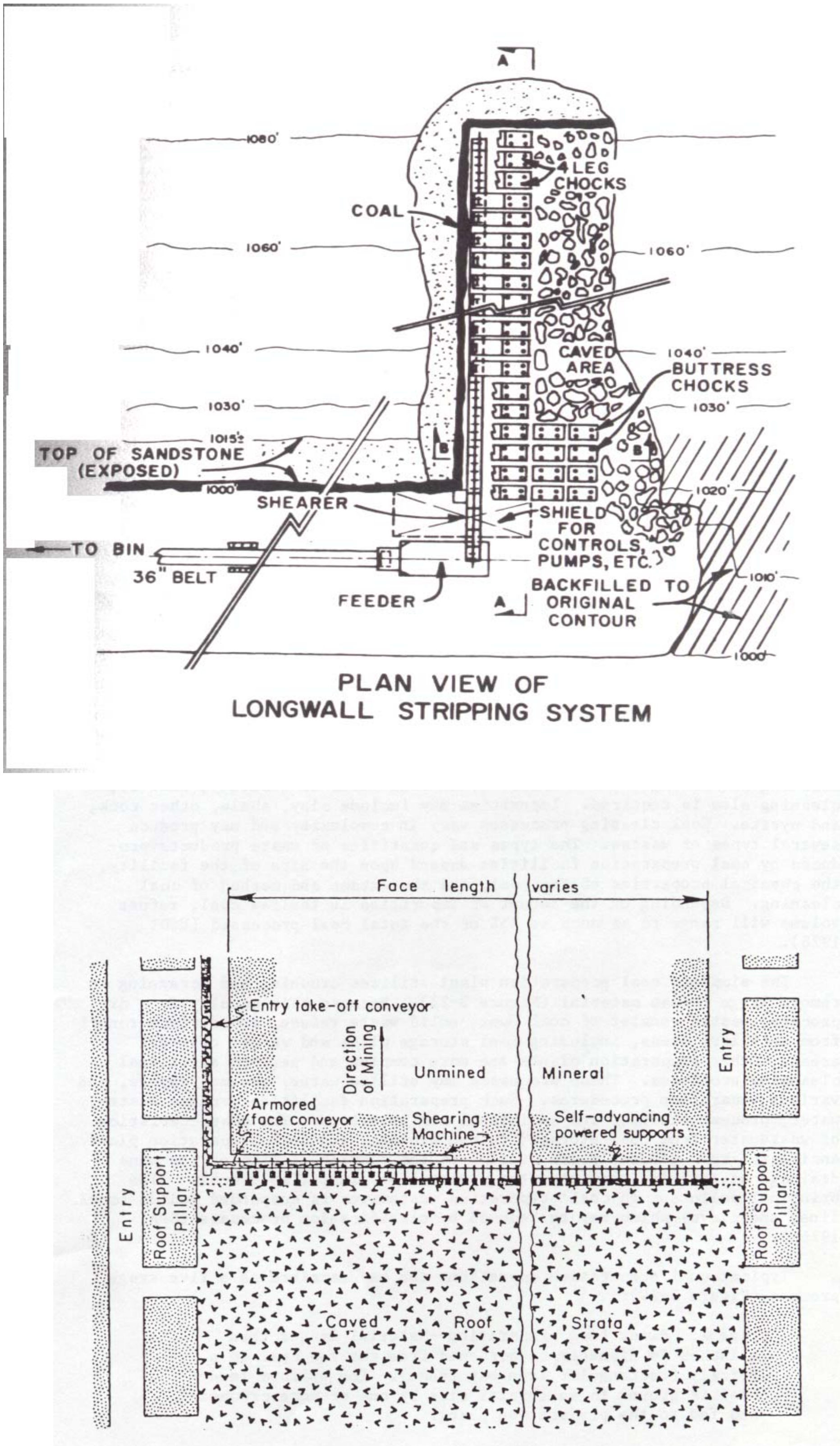
c. Longwall Mining

Longwall mining is characterized by use of mobile mechanical supports for the mine roof and provides essentially complete coal extraction within the working area of the longwall equipment. In the longwall mining method, two or three parallel entries, or *headings*, are driven into the coal seam via continuous room and pillar methods to a planned maximum extent, where a cross heading is driven between the ends of the entry headings to create a *panel*. These panels are usually 850 to 1,100 feet in width and 7,500 to 15,000 feet in length (Suboleski, 1999b). A shearer or plow-type cutting head mounted on a track then travels back and forth across the cross heading, cutting the coal off in strips and working backwards towards the origin of the panel. Shearers are the more popular of the two heads, cutting 30 to 42 inches of coal per pass compared to 6 inches per pass for a plow. In both cases, the traveling cutting head is mounted on an armored face conveyor, which stays parallel to the coal face being mined and transports freshly cut coal to the mine's main haulage system. When the end of the coal face is reached, the cutting direction is reversed, and the longwall miner moves back across the coal face in the opposite direction. The conveyor and cutter head are protected by a line of hydraulic roof supports, or *shields*, that are advanced with each progressive cut and keep the equipment parallel to the coal face. As the shields advance, overhead stresses cause the roof in the mined-out area behind them to collapse, filling the mine void with broken rock known as *gob*. Cracks resulting from the mine roof collapse do not generally propagate to the surface, but the entire surface area over a panel will subside to some degree as mining progresses. Subsidence is normally about two thirds of the thickness of the seam being mined (Suboleski, 1999a). Figure III.I-4 shows a working cutting head and shield arrangement at a coal face, and Figure III.I-5 depicts a typical longwall mine plan.

Figure III.I-4
Longwall Cutting Head with Shields

Modified from Suboleski, 1999a

Figure III.I-5
Typical Longwall Mine Plan



Longwall mining has several advantages over room and pillar mining, including a higher coal recovery rate of up to 85 percent (McDaniel & Kitts, 1999) and higher production rate when the longwall is operating. Longwall mining is the only practical method for seams of greater than 1,500 feet in depth (Suboleski, 1999b). This method of underground mining does require a relatively high capital investment and is not practical for reserves of less than 50 million tons, with double that figure preferred. A reserve of six feet or greater in thickness and of sufficiently regular shape to accommodate rectangular panels is also required (Suboleski, 1999a). Longwall mines are generally safer due to the overhead protection of the shields, provide better subsidence control over local pillar removal, and have lower support requirements, such as roof bolting, rock dusting (for fire suppression), and ventilation controls. However, longwall mines can suffer production delays when moving equipment between panels, and may not be suited to coal seams with many irregularities or in difficult geologic conditions. The equipment is also specific to the mine and may not be transferable to other sites after mining is completed. Some room and pillar mining is usually associated with longwall mining to extract coal reserves between the panels.

2. Surface Mining Methods

Surface mining involves removal of overburden to expose underlying coal seams for extraction, although surface mines may also employ surface-directed underground equipment, called augers or thin-seam (highwall) miners, for secondary extraction of coal without overburden removal. Surface mining is categorized by three basic operational methods: contour mining, area mining, and mountaintop removal mining. Secondary extraction associated with surface mining, collectively known as *highwall mining*, occurs after the final highwall limits have been reached. Underground mining entries may sometimes be employed when the limits of surface mining are reached. Surface mines can employ any combination or all of these methods to maximize the coal recovery from a given land parcel. Because excess spoil disposal can be potentially associated with any of these mining methods, this topic is discussed separately in Section III.K. Prior to discussing the individual mining methods, several common features of surface mines are reviewed for background.

a. The Surface Mining Process

Although approaches to surface coal mining can very greatly between individual mine sites, all share a series of common site development, operational, and reclamation activities, as follows:

1) Access Development – The first step in mine development is construction of a primary haul road to the mine site to provide public road access for equipment, employees, and supplies. Other internal haul roads allow movement of equipment and the haulage of coal and overburden, and these are developed as access is needed to working areas within a mine site.

2) Erosion and Sedimentation Controls – These controls include sedimentation ponds constructed to prevent siltation of receiving streams, and ditches constructed to convey runoff from disturbed areas to the sedimentation ponds. Diversion ditches are also built around areas affected by mining to divert runoff from upslope areas to natural drainageways. These facilities must be constructed prior to initiation of earth disturbance in a given area. Ditches may be temporary or permanent, and sedimentation ponds may also be left in place after mining if required for long-term

runoff control or to serve as an ecological component of the reclamation plan. In some cases, permanent stream relocations are also employed to reroute streams around working areas in reconstructed channels.

3) Clearing and Grubbing – This activity involves the removal of trees, stumps, shrubs, and other vegetation from the area to be affected. This allows for more efficient removal of topsoil, if topsoil salvaging is employed on a mine site for later use in reclamation. If topsoil is segregated, a dozer will typically strip the upper 1 to 2 feet of soil from mining areas for placement in stockpiles, which may be temporarily seeded with fast-growing grass species until needed for reclamation. On many sites within the study area, the existing topsoil is very thin and cannot be efficiently stripped or segregated for later use. Marketable timber is usually harvested prior to clearing and grubbing, and residual vegetative material may be wind-rowed and burned, disposed of in mine pits prior to backfilling, or reserved for reclamation uses. Valley fill areas are cleared and grubbed prior to fill placement to prepare the foundation to ensure stability of the fill.

4) Excavation – This activity is the physical removal of overburden soils and rock overlying the coal seams to allow equipment access for removal and haulage. Unconsolidated surface material and weathered bedrock can usually be excavated by equipment without blasting. To access seams in deeper, unweathered bedrock blasting is employed as part of the excavation process. In the blasting process, bedrock areas are first benched to create a level working surface, and a rotary drill then drills a pattern of holes, also known as "shot holes," to the next planned bench or coal seam to be exposed. A blasting agent (typically ammonium nitrate and fuel oil) is placed in the blast holes and connected by a electric or non-electric energy distribution system. Timing of individual detonations within the blast pattern allows for control over the fragmentation and intensity of vibrations. The void left after excavation is referred to as a mine *pit*. The broken rock that is removed is known as *spoil*.

5) Backfilling – After coal removal, mine pits are backfilled to dispose of spoil from new excavations and restore the ground surface. Backfilling, also known as *backstacking*, may be accomplished by a variety of methods, including casting by draglines or shovels, cast blasting, dozer pushes, and truck haulage and dumping. Normally, mining will advance through a mine site in a series of adjacent excavations, or *cuts*, with the spoil from each new cut being placed in the pit void left by the previous cut. Almost all sites generate excess spoil that must be hauled to valley fills or other disposal fill types adjacent to the immediate mining area.

6) Regrading – This activity is the leveling of spoil areas to final reclamation contours. After spoil casting or haulage and dumping, spoil areas usually have a very irregular surface that must be smoothed to better resemble a natural land surface. Regrading of spoil is primarily accomplished by dozers, with the final site topography determined by the site reclamation plan and postmining land use. These plans generally aim to achieve the SMCRA definition "Approximate Original Contour," or AOC, which is discussed in greater detail later in this section.

7) Topsoil Redistribution or Substitution – The final earthmoving activity is redistribution of stockpiled topsoil over the reclamation surface, or preparation of a rock-based topsoil substitute, if topsoil replacement is not employed. Where topsoil has been stockpiled, it is redistributed by dozers or scrapers at an application rate determined by available quantities, usually between 4 and 12 inches. On many mine sites in the study area, the existing topsoil is very thin or scattered among rock outcrops and cannot be efficiently stripped or segregated during clearing and grubbing, or has a low initial productivity. In these cases, a method of soil substitution has been developed, whereby acceptable strata in the overburden are placed on the regraded spoil surface. This material is then mechanically broken by passage of tracked equipment to produce a relatively fine-grained growing substrate. Use of topsoil substitutes requires a variance during the mine permitting process.

8) Revegetation – Following spreading or preparation, the topsoil or topsoil substitute is amended with fertilizer to create a fertile growing substrate, and planted and seeded with species mixes reflecting the intended postmining land use. Most mine sites in the study area occur in forested areas, and tree planting is sometimes part of the revegetation process. Other shrub and herbaceous species may be included in the revegetation mix for wildlife habitat. Planting is normally conducted by hand or with tractor-towed mechanical planters, and seeding accomplished using hydroseeders that concurrently apply a stabilizing cellulose mulch and fertilizer. Revegetation planting and seeding mixes are approved as part of the mine permitting process. If vegetation types or postmining land uses are proposed that differ from the premining land use of a site, then variance for postmining land use change must be approved.

a.1. The Importance of Stripping Ratios

Another commonality between surface mines is the method of determining the extent to which a coal seam is economically feasible for mining, and consequently determining which mining method or methods are best applied to that seam as it relates to other seams on a mine site. The principle method of assessing mining economics for a coal seam is its *stripping ratio*, which is typically expressed as bank cubic yards (in-place volume) of overburden moved per clean ton of coal produced. The higher the stripping ratio, the higher the cost of producing coal. When setting *highwall limits*, or the maximum horizontal distance into the hillside to which a coal seam will be mined, the stripping ratio of the seam is integrated between its low cover outcrop and potential high cover highwall limits until an overall stripping ratio is achieved that will allow acceptable production costs and profit. When an overlying coal seam is present, its coal production volume is added to that of the underlying seam and reduces its stripping ratio. Thus, removal of multiple coal seams may allow economical mining of areas of an underlying coal seam that otherwise could not be mined to that extent. Determination of stripping ratios and mine practicality for a given mine site is now largely accomplished by three dimensional modeling using mine planning software.

The determination of what stripping ratio represents an economically mineable situation depends on overburden type, excavation costs, coal market value, topography, and haulage distances. Stripping ratios of 15:1 to 20:1 are generally considered the upper limit for mine feasibility by any method (Suboleski, 1999a). Changes in production costs and coal market conditions may result in differing economic stripping ratios over the life of a mine, and mine plans must retain the flexibility to respond to these variations by increasing or decreasing the extent of mining within the scope of the original mine plan.

a.2. Approximate Original Contour

Under SMCRA, surface mines are required through the process of backfilling and regrading to restore the mine site to AOC, defined by SMCRA as follows:

> "AOC means that surface configuration achieved by backfilling and grading of the mined area so that the reclaimed area, including any terracing or access roads, closely resembles the general surface configuration of the land prior to mining and blends into and complements the drainage pattern of the surrounding terrain, with all highwalls and spoil piles eliminated." Section 701(2)

Because the AOC concept is not quantified, interpretation of what constitutes AOC is open to subjective determination. In general, maximization of spoil placement in the backfill areas on the mine benches and a rolling regrade configuration resembling surrounding topography is accepted as AOC. When these conditions are not met, an AOC variance is necessary. The regulations and policies regarding achieving AOC are discussed in greater detail in the No Action Alternative of this EIS.

b. Contour Mining

Contour mining takes place in mountainous or rolling hill areas where it is uneconomical or unfeasible due to property ownership conflicts to remove all of the overburden from a particular coal seam, and mining is limited to the side of a mountain or to the end of a ridge line. When occurring on the end of a ridge line, this method may also be referred to as *point removal*. In contour mining, operations progress along the outcrop of a coal seam, removing overburden inward towards the mountaintop or ridge core to the highwall limit of that coal seam as determined by its stripping ratio. This results in mine cuts that wrap around mountaintops or ridge lines parallel to contour in a sinuous pattern dictated by topography. Contour cuts may be conducted on multiple seams on a given mountain or ridge line, stepping upward in elevation in a layer-cake pattern and extending to greater depths because of the stripping ratio benefits of overlying seam mining. The contour method is highly dependent on mobile equipment and does not employ draglines. The lateral movement, or *haulback*, technique is the most common contour mining style. A picture of a typical contour cut is provided by Figure III.I-6.

Figure III.I-6
Typical View of a Contour Mine Cut

Source: Carr, 1999

To begin a contour mine, an initial cut, known as a *box cut*, is opened at the coal outcrop and excavated to the highwall limit, forming a mine pit. Spoil material from this first cut may be temporarily stockpiled on site for use in later backfilling, but is usually hauled to an excess spoil disposal area. On steep-sloped sites, some spoil from almost all succeeding cuts must be disposed of in fills as well. After the coal is removed from the first pit, a second cut continues along the contour following the coal outcrop, and spoil from the second cut is placed in the first pit area. The preferred methods of spoil movement are shovel, hydraulic excavator, or loader and truck combinations. Pan scrapers may also be used in a cycling pattern, but this approach is now largely obsolete. The selective placement of spoil by trucks allows for secondary extraction activities, such as highwall mining, to take place on the usually narrow contour mine bench. Successive cuts continue along the contour, with new spoil being placed in the previous pits. Where multiple seams are being mined, the spoil may also be placed in the downhill pits of lower seams. Final reclamation grading of the highwalls follows the approximate original slope of the hillside that was mined.

Contour mining may be employed for the entirety of a mine operation or found in association with the other surface mining methods to develop areas for larger equipment, recover low elevation coal seams on steep slopes, and seams from areas of valley fills prior to fill placement. Contour mines offer the advantages of mine plan flexibility, generally lower capital costs, at least partial recovery of coal reserves from steep sites, and the ability to adjust stripping ratio limits in response to market changes. The economic stripping ratio limit for contour mining is approximately 10 to 12 (Suboleski, 1999a). This method is not suitable for large coal reserves and does require a disposal area for spoil on steep-sloped sites. If used for the entirety of a mine operation, contour mining may also leave deeper coal reserves isolated from future recovery within the cores of mountaintops and ridge lines.

c. Area Mining

Compared to contour mining, area mining takes place over a range of slope conditions and is not restricted to the side of a mountain or ridge line. Area mining occurs when relatively low slopes and/or multiple coal seams produce stripping ratios favorable for mining across topography, rather than around it. Although area mining may affect an entire mountaintop or ridge line, it is considered a separate entity from mountaintop removal in that an area mine site must be reclaimed to AOC. All coal seams may not be mined across their entire extent. The area mining method will generally have larger working areas than the contour method and may employ large earthmoving machines for primary coal production.

Area mines may use a cross-ridge approach, where mining progresses parallel to the long axis of a ridge; or a side-ridge approach, where mining progresses perpendicular to the long axis of a ridge. In both cases, cuts are oriented perpendicular to the direction of advance. The cross-ridge technique provides consistent operational costs and coal production by simultaneously mining the high stripping ratio coal at the ridge crest and the low stripping ratio coal at the coal outcrops. Consequently, each perpendicular cut averages out to an economically acceptable stripping ratio. The side-ridge approach allows for easier cast or other movement of spoil into valley fills paralleling ridge lines, but generally progresses from low stripping ratios to high and back to low on the opposite side of a ridge, requiring a balance of mining costs over a longer time period. Both approaches and several directions of advance may be present on a given mine site to make best use of the local topography with regards to overburden removal efficiency and equipment travel distances.

Area mining may begin by excavation of an initial cut across the entire width of a mountaintop or ridge line containing coal reserves. This initial cut may start as a contour cut on the basal coal seam and progress inward until a linear primary highwall is established perpendicular to the direction of advance. Smaller equipment, such as hydraulic excavators, loaders, and dozers, makes these initial cuts and works in advance of the primary highwall to remove upper strata and coal, and to create a flat working bench for blast hole drilling. In steep slope areas, spoil from development activities is often placed in a valley fill or other type of disposal fill. Successive highwalls are opened by taking smaller block cuts from and parallel to the face of the primary highwall. Spoil movement at the primary highwall uses larger equipment, such as draglines, electric shovels, hydraulic excavators, or large loaders, with the latter three loading haul trucks for spoil transport. Spoil may also be moved by the cast blasting method, where the force of the blast is used to cast material (30-60 percent) into an adjacent open pit, and dozers then used to push remaining spoil onto the backfill to expose the coal. Where potentially acid-forming overburden is encountered, this material may be segregated for special placement in backfill pods to isolate it from oxygen and water. Figures III.I-7 and III.I-8 illustrate how an area mine will progress using the various methods for spoil movement. Figure III.I-9 provides a photograph of this type of mining progression using a dragline, with development equipment working to the far left, bench drilling in preparation for blasting in the left center, active spoil movement in the center, and backfilling occurring to the right.

Figure III.I-7
Multiple Seam Surface Mining Sequence - Dragline, Shovel/Truck, and Loader/Truck Operation

Modified from OSM AOC Presentation, 1999

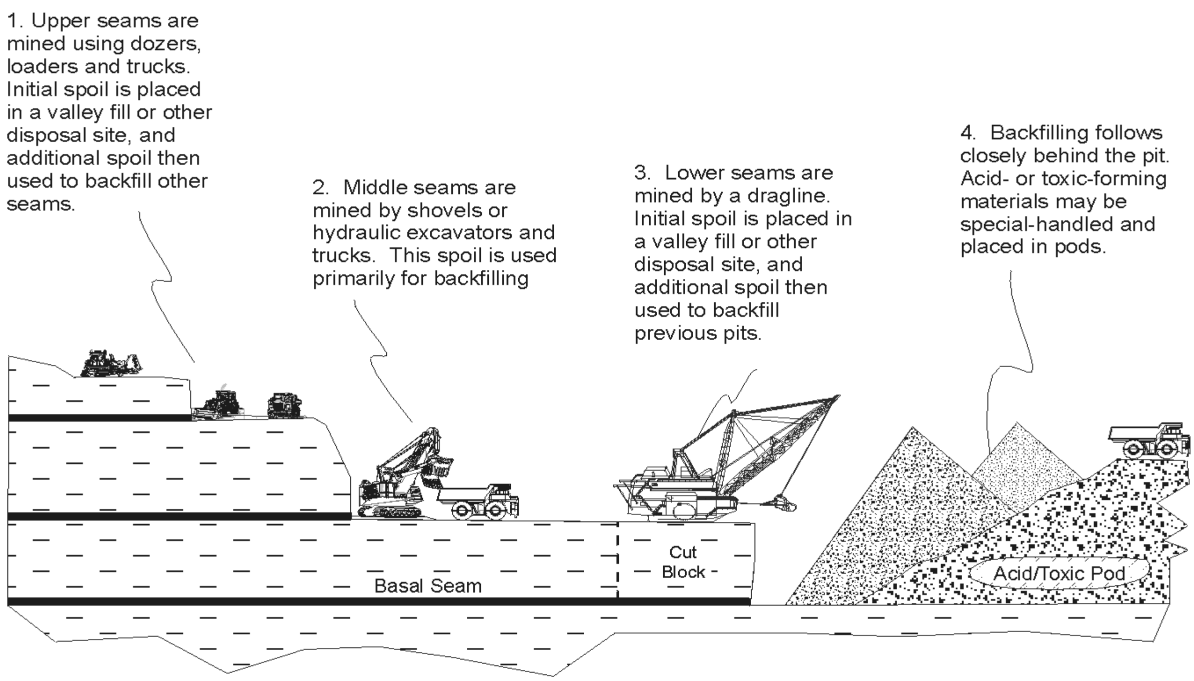
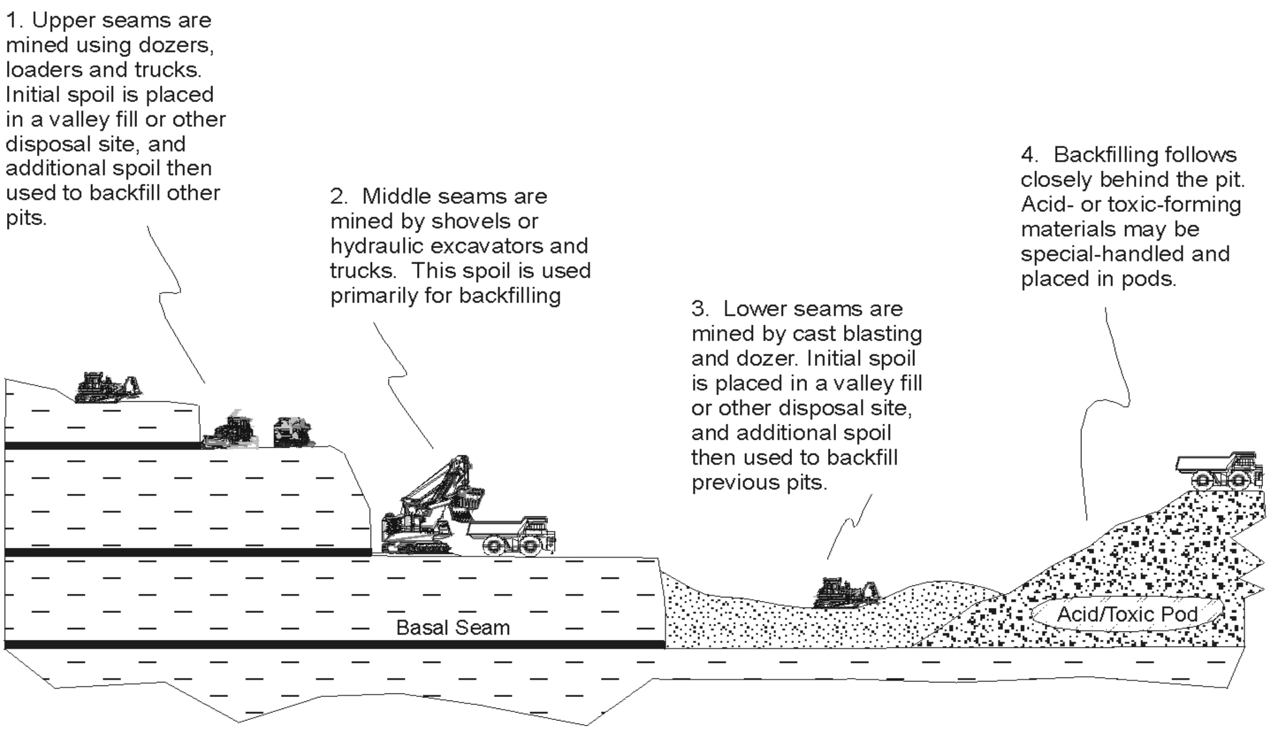
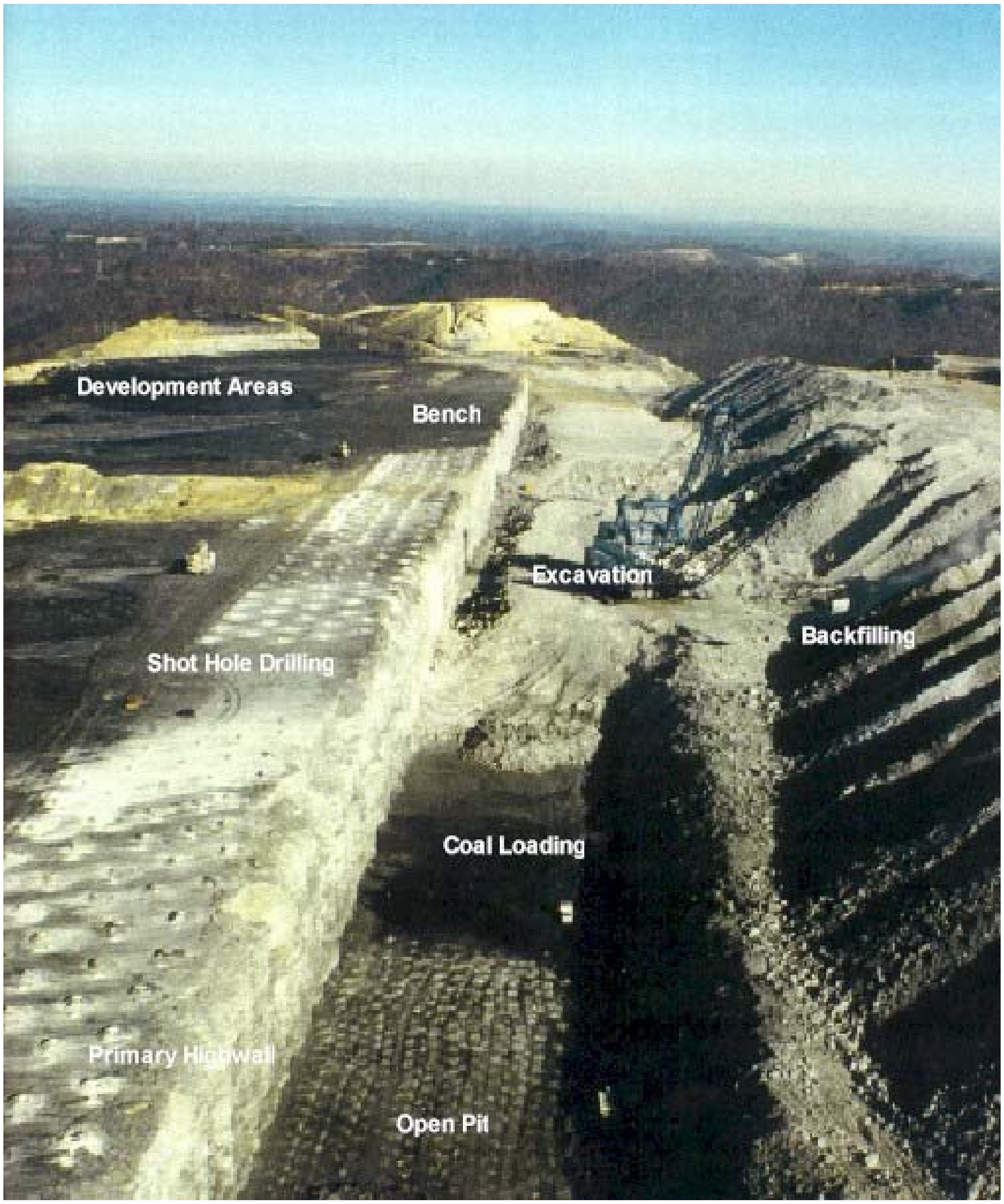


Figure III.I-8
Multiple Seam Surface Mining Sequence - Shovel/Truck, Loader/Truck, and Cast Blasting/Dozer Operation



Modified from OSM AOC Presentation, 1999

Figure III.I-9
Typical View of Area Mine Progression



Modified from Arch Coal, Inc., 1999

As with contour mining, spoil from new cuts is used to backfill previous pits. When cast blasting is employed, spoil is moved away from the currently open highwall, rather than against it, leaving a single, long open pit ready to receive spoil from the next cast blast. If a dragline is used with cast blasting, it usually rests on a prepared pad on the spoil within a cut that has been blasted. For a conventional blast, where a highwall is broken in place, the dragline usually rests on the adjacent intact highwall.

Shovels, hydraulic excavators, and loaders work within the pit. Movement of spoil by dragline results in long, linear ridges of spoil across the backfilled surface, while truck placement associated with the other types of production equipment may be more selective. Regrading of backfilled spoil for reclamation progresses behind the working areas.

If this basic mining approach were carried completely across a mountaintop or ridge line on the basal coal seam, crop to crop, it would be considered a mountaintop removal mine. However, an area mine will typically encounter high stripping ratios on the upper seams as topography changes or other restrictions that preclude complete removal of the basal seam. Secondary extraction, such as highwall mining, may be conducted to recover part of these otherwise inaccessible reserves. Most area mine operations will also contain components of contour mining to recover low elevation seams on steep slopes and those that would otherwise be buried in valley fills.

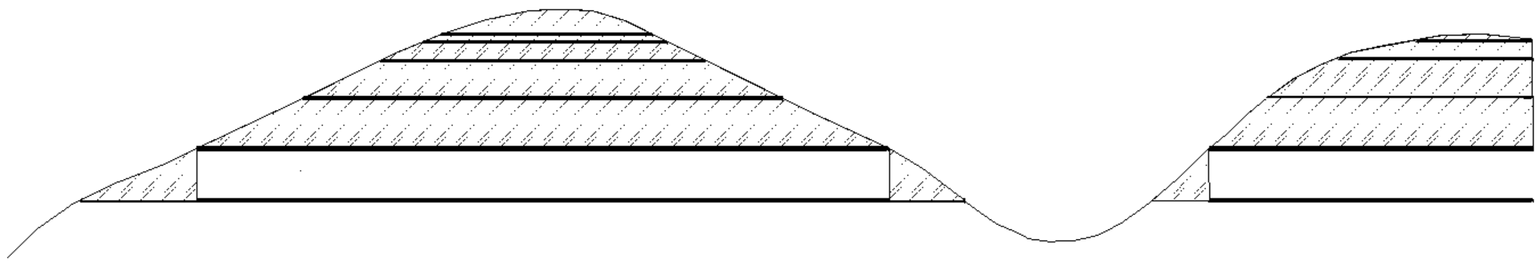
Area mining offers the advantages of a high recovery rate from the reserve, high production rate potential, and the potential to restore a site to AOC. However, area mining requires a large capital investment and large reserve base to be practical ($\geq$1,000,000 tons), and can entail disposal of large volumes of excess spoil.

d. Mountaintop Removal Mining

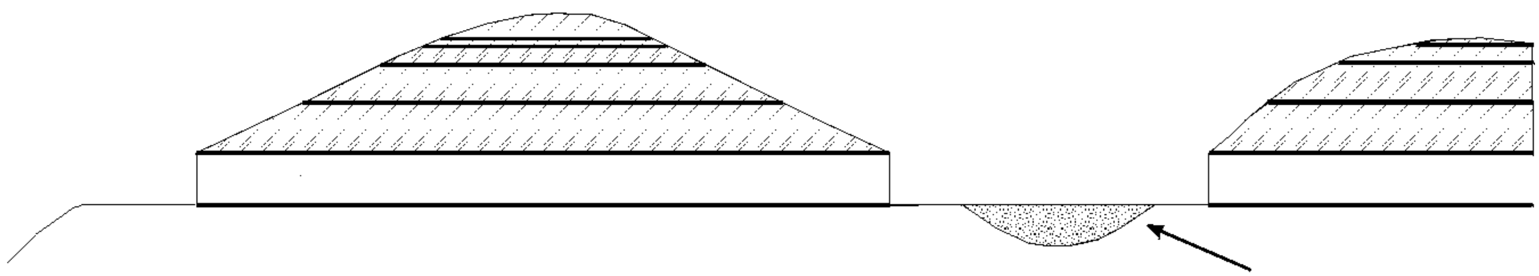
Mountaintop removal mining (MTR) is considered a special case of area mining that results in complete recovery of coal reserves above a basal coal seam. Coal extraction must be accomplished by removing all of the overburden above the basal seam. Reclamation creates a level plateau or gently rolling contour that both has no highwalls remaining and is capable of supporting certain post-mining land uses. In practice, the term mountaintop removal is used more broadly and sometimes applied to sites not meeting these criteria if still descriptive of the overburden removal method.

The basic operational sequence, highwall progression, and backfilling methods used in MTR are the same as those used for area mining, and so are not repeated here in detail. The progression of equipment shown by Figures III.I-7 and III.I-8 would simply continue working through the mountaintop or ridge line until the outcrop of the basal coal seam was encountered on the opposite side. To illustrate the concepts of excess spoil disposal and topographic changes that may be associated with MTR, Figure III.I-10 shows on a broader scale the sequence of steps in a hypothetical MTR operation that uses the side-ridge technique with a valley fill. Note that the quantity of spoil available for backfilling, and consequently the regrade elevation, diminishes in the latter cuts because of the initial movement of excess spoil to disposal areas.

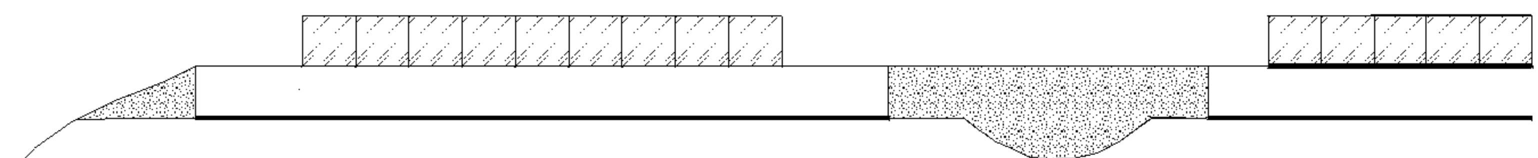
Figure III.I-10
Typical Mountaintop Removal Mining Sequence



1. Existing topography showing overburden and coal seams to be mined.

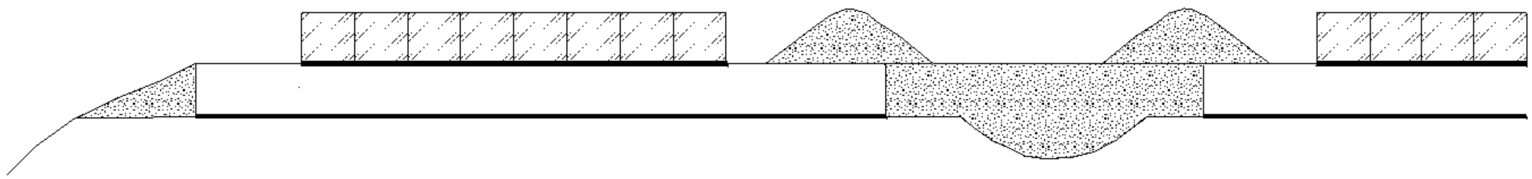


2. Contour mining extracts lowest seams on slopes and in valley fill area; initial spoil is placed in valley fill.

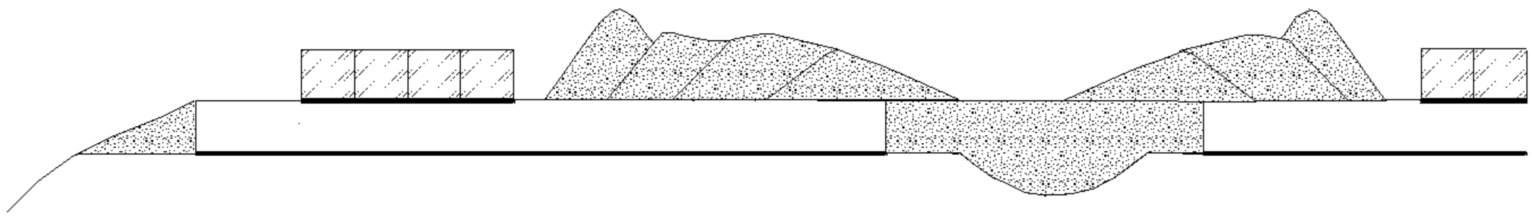


3. Upper seams are mined, with spoil placed in contour cuts and valley fill.

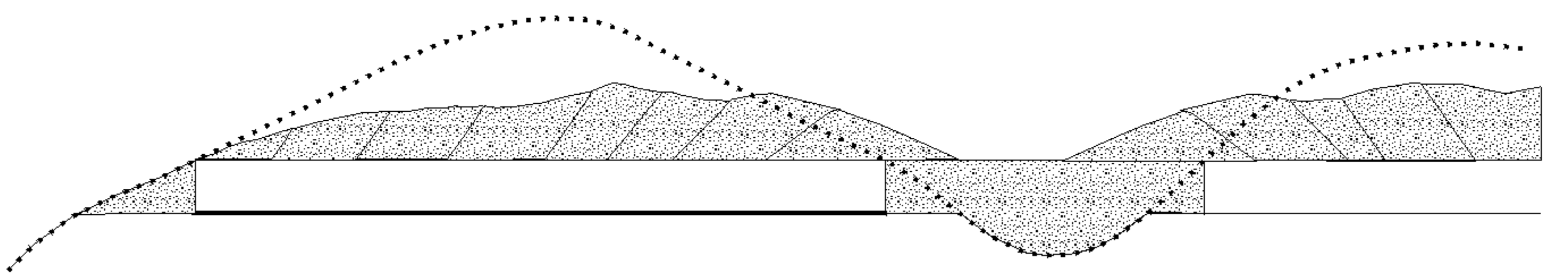
Figure III.I-10 (continued)
Typical Mountaintop Removal Mining Sequence



4. First cuts are mined, with spoil placed on top of valley..



5. Subsequent cuts are mined, with spoil used for backfilling and regrading.



6. Mining is completed, along with backfilling and regrading (original topography is superimposed).

Because MTR operations can balance mining costs between high and low stripping ratios, this mining method can achieve essentially 100 percent recovery of coal reserves, a portion of which might otherwise be permanently isolated beneath the reclaimed mine site. Stripping ratios of 13 to 20 may be economically feasible for large operations (Suboleski, 1999a). Reclaimed MTR sites generally have lower slopes and topographic relief than original conditions, and must be authorized only where intending agricultural, residential, industrial, or commercial uses. This type of operation also precludes any future disturbance of the site by re-mining, since no coal remains to be feasibly recovered from the surface. MTR operations account for approximately one quarter to one third of Appalachian coal production (Suboleski, 1999a).

Like area mines, MTR operations require large capital investments and working reserves to be feasible, and can require disposal of substantial amounts of spoil in valley fills. Mine planning can also be more complicated to achieve a net profit from the overall operation.

e. Highwall Mining

Augering and continuous highwall mining are secondary extraction methods that allow additional coal extraction from beneath highwalls after their stripping ratio limit has been reached. This is the last activity to be conducted in a mine pit before it is backfilled.

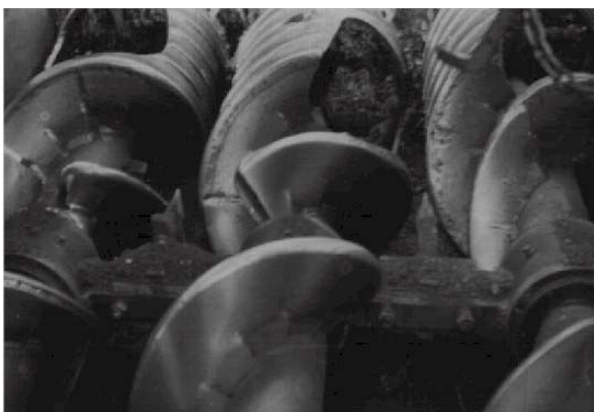
In auger mining, horizontal holes are drilled into a coal seam with auger stems driven by a rotary shaft with a hydraulic ram, working on the principle of an Archimedes screw. The auger head diameter is usually two-thirds the coal seam thickness, and augers may come in single, dual, or triple head configurations. While auger holes can reach a distance of 400 feet, 200 feet or less is a more practical limit, as the auger may intersect the bottom strata or wander laterally into adjacent holes as its depth of penetration increases. Augers have a maximum recovery rate of about 33 percent (Suboleski, 1999a). As coal is produced from an auger hole, it is usually loaded directly into haul trucks using a front end loader. Figure III.I-11 shows typical components of an auger system.

A continuous highwall mining machine, or “highwall miner,” may be used in place of an auger when coal seam characteristics permit. A continuous highwall miner typically has a front set of rotary cutting heads that cut coal from a seam beneath a highwall and direct it onto following conveyor cars for delivery to the pit area, where a stacking conveyor piles the coal in preparation for truck loading. A launch vehicle may be used to direct the initial entry of the miner, with a dedicated wheel loader to move the vehicle to the next position. Depth of penetration for a continuous highwall miner is variable depending on geologic conditions, but can reach 400 to 1,000 feet. Continuous highwall miners have a better recovery rate than augers, up to 45 percent of the reserve (Suboleski, 1999a). Typical components of a continuous highwall mining system are shown in Figure III.I-12.

Figure III.I-11
Typical Auger System Components

Single Stem Augers

Dual Stem Augers



Triple Stem Augers

Auger Driving Rig

Modified from Carr, 1999

Figure III.I-12
Typical Continuous Highwall Miner System Components

Continuous Miner

Conveyor Cars

Launch Vehicle

Stacker Conveyor

Modified from Carr, 1999

Highwall mining can reach coal reserves that are not economical to mine from the surface and is relatively inexpensive compared to other production methods. However, highwall mining has a low recovery rate due to the coal pillar, or *web*, that must remain intact between each hole. Maintaining this web is critical in preventing the intersection of holes, maintaining highwall stability, and preventing loss of equipment in collapsed holes. In many cases, highwall mining negates any possibility of future surface mining at a site because of mechanical damage to the coal seam and higher stripping ratios resulting from removal of part of the reserve. Normally, highwall mining can only be conducted in a down-dip direction to prevent excessive dewatering of the overlying strata or potentially dangerous dewatering and contamination from intersection of deep mine workings. Both augers and continuous highwall miners are specialized machines with sporadic use on a mine site, so they are normally provided by contractors rather than owned by a coal company.

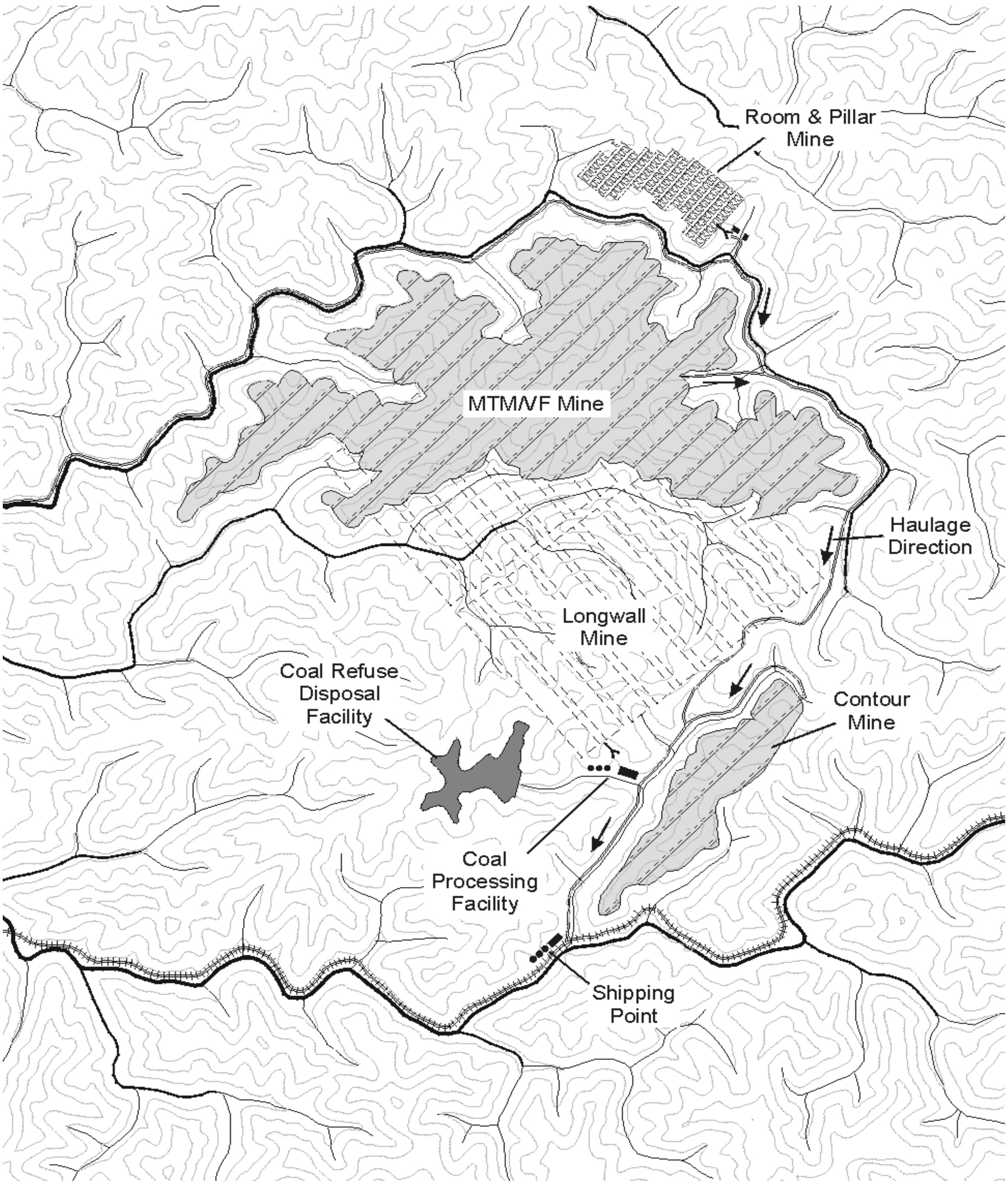
3. Mountaintop Mining Complexes

As defined for use in this EIS, MTM/VF mines are contour, area, or MTR operations that generate excess spoil and dispose of it in the heads of hollows or valleys of streams. Because MTM/VF mines are a relatively recent development compared to centuries of underground mining and other surface works, they typically rely on existing transportation (railroad or barge) and marketing infrastructures from earlier mining periods. Multiple independent surface and underground mine sources may contribute to a single shipping point directly or via a coal processing facility. These mines and facilities are seldom owned or operated by a single corporation, but rather are tied together by economic necessity in a loose production-processing-transportation group sometimes referred to as a *mining complex*. (Note that this term is not used in the same context as the Kentucky AOC term "mining complex.") The major components of a typical mine complex are shown in a hypothetical layout presented on Figure III.I-13 and summarized in the following.

a. Shipping Point

Long distance coal transportation to consumers normally occurs by way of railroads or river barges, with river barges being the less expensive of the two alternatives. Local transportation, within about 10 to 12 miles of a mine site, is usually by truck. When railroads or barges are used, a shipping point is required to provide transfer facilities from truck haulage or belt conveyors to rail cars or barges. In some cases, a processing facility may serve as a shipping point if it is located on a rail line or a navigable river. Shipping points require a large capital investment to initially develop and are very dependent on location in major stream or river valleys to allow access by railroads or barges. As such, they are a consideration in the geographic siting and extent of mining complexes and may form the hub of mining development.

Figure III.I-13
Typical Mining Complex Components



b. Processing Facility

Both underground and surface mine coal may contain excessive sulfur or other impurities and not be suitable for immediate use by the consumer in its state at the mine mouth. This coal must be processed to remove impurities or blend with higher quality coal before delivery to the shipping point. Processing facilities may include such mechanisms as screens to separate coal into acceptable size grades, crushers to further reduce coal to desired size grades, and washing plants to clean rock and sulfur impurities from coal. Washing plants use a high density medium, usually magnetite, to float and separate low density clean coal from these contaminants with a closed-loop water recycling system. Reject materials from screens and crushers and residue from washing plants are hauled or pumped to coal refuse disposal facilities. Processed coal may then be blended with other coal stock to achieve the desired market quality grades. Blending may be accomplished by mobile equipment, such as loaders, or using a system of mobile stacking conveyors. Stockpiles and/or silos are typically present on site to store raw, cleaned, and blended coal prior to transport to the shipping point.

Coal processing facilities may be associated with older underground mines and may pre-date the surface operations from which they receive coal. In most cases they are owned by the MTM/VF operations which they serve or a related company. Larger MTM/VF operations often construct their own on-site processing facilities.

c. Coal Refuse Disposal Facility

Reject material, or coal refuse (impurities from the cleaning of coal, often consisting of shale), is typically disposed of off-site of a coal processing facility due to land occupancy requirements. Most older coal refuse disposal facilities are a large impoundment formed by constructing a berm across an existing hollow or valley, and essentially become “valley fills” by the time refuse disposal is completed. The berm is often constructed from the coarser refuse material in a series of lifts as new material accumulates behind the berm. Refuse with small particle sizes, known as *fines*, is usually pumped in slurry form from the processing facility to the refuse impoundment behind the berm. Aside from storage, the refuse impoundments serve to settle fines and decant clean water from the pumping slurry. Anecdotal evidence indicates that few facilities of this type have been permitted in the last 15 years, and that combined refuse disposal is more common today.

Coal refuse disposal facilities are most often operated by the attendant processing facility. Coal refuse disposal facilities are long-term investments because of their size, support facilities, and reclamation requirements. The typical life of a coal refuse disposal facility is approximately 20 years.

d. Surface Mines

One or more surface mines may contribute to a single coal processing facility and/or shipping point. For the hypothetical example on Figure III.I-13, both a large MTM/VF operation and a smaller contour mine contribute to the single processing facility and shipping point. Because of multiple seam mining and in-pit blending capabilities, surface mines can more readily meet changing market demands for coal quality blends than underground mines. Under normal circumstances, about 10 to 15 percent of surface mine output will go to a processing facility for cleaning and blending, and the rest will be transported directly to the shipping point. Both transport systems rely on overland truck haulage more frequently than belt conveyors. Anecdotal evidence suggests that the combined haulage distance to the processing facility and processing facility to shipping point is usually about 12 miles and can be 50 miles or more when coal prices support it.

e. Underground Mines

Usually, one or more large underground mines will be associated with a coal processing facility, and may deliver their output to it by overland trucks or belt conveyors. Additional smaller underground operations may also be present, relying exclusively on overland truck haulage and sometimes referred to as “road coal” operations. The hypothetical example on Figure III.I-13 includes a large longwall mine feeding its output directly to the processing facility by belt conveyor, and a small room and pillar mine hauling its output to the facility by truck. Underground mines will be at approximately the same distance from coal processing facilities and shipping points as surface mines.

J. MTM/VF CHARACTERISTICS

As defined for use in this EIS, MTM/VF mines are surface coal mine operations in steep terrain that generate excess spoil and dispose of it in the heads of hollows or valleys. The general mining methods used for MTM/VF operations have been presented in Section III.I.2. Because all of the surface mining methods previously discussed may generate excess spoil over a wide range of mine sizes, there is considerable variation in individual mine site characteristics associated with MTM/VF. Topographic and geologic differences also produce significant variations in mining practices and scale of excess spoil disposal between regions and states within the study area. This section focuses closer on the typical settings, mine site components, and operational characteristics that are associated with MTM/VF mining in the study area.

1. General Setting

For the most part, trends in topography, geology, and demographics have produced a relatively consistent setting for MTM/VF mine sites and their surroundings within the study area. The following summarizes some of the specific site features that these mines have in common.

a. Topography

By the definition applied in this EIS, MTM/VF mines are/will be located on mountaintops and ridge crests with attendant hollows and valleys in which excess spoil is/will be disposed. The exact topographic setting will vary from site to site, but can be expected to follow this theme. Degree of topographic relief varies within the study area, generally increasing from southeast to northwest. Refer to the Physical Setting section of this EIS for a detailed description of study area topography and distribution of steep-slope conditions.

b. Coal Reserves

MTM/VF operations include single-seam contour mining, multi-seam area mining, or multiple seam mountaintop removal mining, or, combinations of all of these in a single permit. The actual number of seams mined is dependent on thicknesses and depth intervals. Some mountaintop removal operations may mine as many as 18 seams. The depth to the lowest, or basal, seam to be mined is normally about 250 feet, but may be as much as 600 feet on sites with favorable stripping ratios (Meikle & Fincham, 1999). The depth to the uppermost seam to be mined is usually around 60 feet. The numbers and depths of coal seams mined are generally greater in West Virginia than in Kentucky and Virginia.

Some previous mining may be present within the permit and operational areas of a MTM/VF mine. If previous mining is present, the deeper, thick coal seams will most likely have been mined by underground methods, and some may still be in active production. Readily accessible shallow seams may have been removed to some extent by contour methods during the 1900s, and some more recent contour cuts will have employed highwall mining to extract additional coal. Local small room and pillar workings, or "punch" mines, may also be present on the seams to be extracted by surface methods. Natural gas wells are common throughout the coalfields of the study area, and most MTM/VF mine sites will possibly contain one or more active or abandoned gas wells.

c. Transportation Access

MTM/VF mine sites are not typically accessed by public road service, but are generally within several miles of a public road. A coal company will develop its own permitted haul roads and a connection to the public road system, based on the optimum route to coal processing or shipping facilities. Where truck haulage traffic travels on public roads, a coal company may enter an agreement with the road authority to perform certain maintenance activities as compensation for damages from increased truck traffic. In some cases, variances are granted to: 1) close portions of public roads for mine traffic; or, 2) relocate or permanently close a public road to accommodate mining activities. Mine haul roads may also be released for public use after completion of mining, with the local road authority assuming maintenance responsibilities. In these cases the mine company often completes the grade work for the road, and the road authority completes the paving. Where alternative post-mining land uses are approved, the haul road may be upgraded by the operator to state highway department standards as a condition of bond release, in order to fulfill infrastructure requirements.

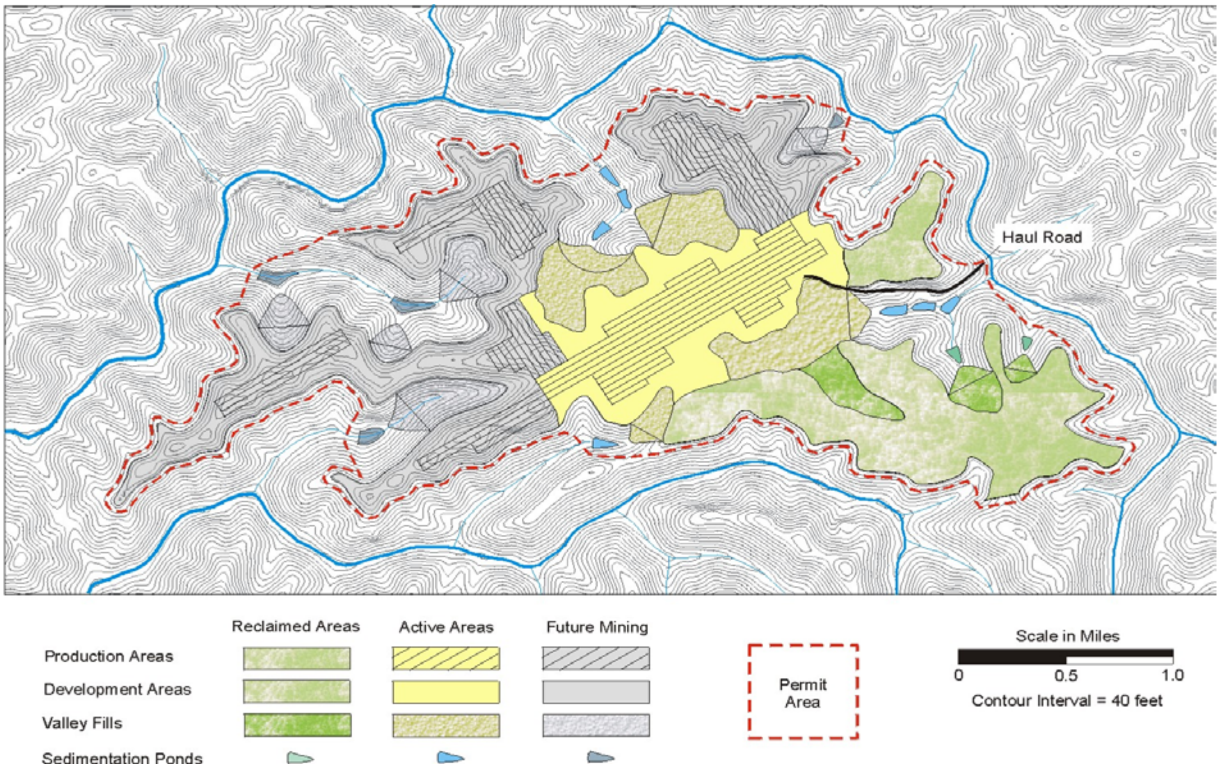
d. Occupied Structures

Private residences and other occupied buildings will not typically be present within the actual mine permit area, but can be adjacent to the permit area. Residential and other forms of development tend to cluster in the bottoms of hollows and valleys, with ready access to public roads, rather than on mountaintops and ridge crests where access and water are more difficult to obtain. The primary constraints imposed on mining by occupied structures are blasting safety, potential for dust migration, drainage control and downstream flooding, well and water supply protection, sediment control structure, backfill, and excess spoil disposal stability. Structures within one-half mile must be offered a survey to document their condition prior to blasting activities. Downstream properties in hollows and valleys may limit the extent to which excess spoil may be placed in these areas, and coal companies will sometimes offer to purchase these lands to increase spoil disposal capacity.

2. General Mine Layout

The typical large MTM/VF mine site will be divided into development areas, production areas, excess spoil disposal areas, reclamation areas, and support areas. The net coal extraction area, consisting of the development and production areas, normally accounts for about two thirds of the total area under permit. Excess spoil disposal areas will account for about one-fifth to one-quarter of the total permit area, with the remainder occupied by support areas, erosion and sedimentation control facilities, haul roads, and areas included within the permit because of geometry but not otherwise disturbed by mining activities. The sum of support areas is generally small relative to the entire permit area. Figure III.J.-1 provides a hypothetical layout for a mine site with a typical scale and features found in mountaintop removal operations.

Figure III.J-1
Typical MTR Mine Site Layout

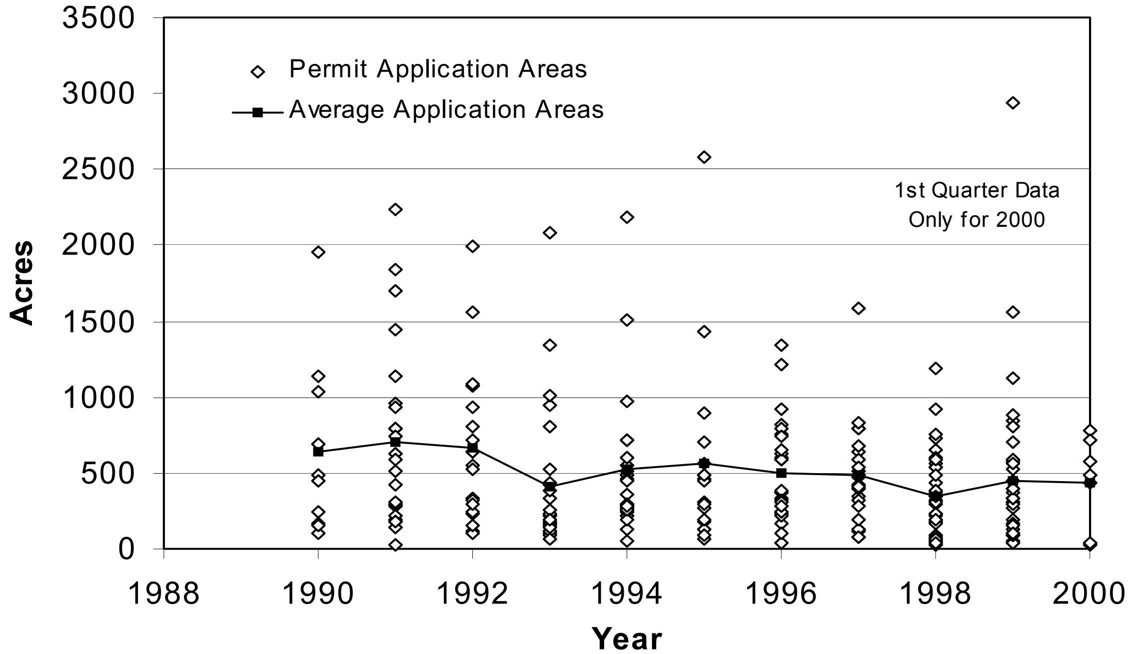


a. Permit Area Trends

Many mine permit applications are extensions of or contiguous additions to existing permitted mining areas, so permit areas themselves do not necessarily represent the size of individual mines. However, they can be generally representative of trends in the scale of mine operations over time, so a discussion of the trends in mine permit size is provided here for each of the four states in the study area.

Permit applications for mine sites in Kentucky having associated excess spoil disposal averaged approximately 500 acres between 1990 and 1998, ranging from a low of about 20 acres to a high of 2,582 acres. The summary of individual and average permit application areas on Figure III.J-2 shows that the size of permit applications in Kentucky has remained relatively consistent over this period, with an overall declining trend in average application size where associated with excess spoil disposal. Permit application size data for Kentucky was taken from a database printout provided by the KYDSMRE for mines proposing excess spoil disposal between 1990 and 1998, and statistics from three valley fill studies prepared by the OSM Lexington Field Office for 1998, 1999, and the first quarter of 2000.

Figure III.J-2
Trends in Kentucky Permit Application Areas



OSM reports only eight issued surface mine permits between 1988 and 1999 in Tennessee with excess spoil disposal. As shown by Figure III.J-3, there are years when no permits with valley fills were issued. The largest application during this time was 664.5 acres in 1999, and the smallest was 78.58 acres in 1991.

Based on a database printout provided by the VADMLR, permit applications for Virginia mine sites with excess spoil disposal fills proposed averaged approximately 218 acres for the 1995-1999 period, having a low value of only about an acre and a high of 1,940 acres. Permitting activity summarized by Figure III.J-4 shows no discernable trends for this period.

A database printout from the WVDEP shows permit applications for steep-sloped mine sites in West Virginia to average approximately 500 acres during the period of 1988 to 1998, ranging from a low of about 15 acres to a maximum of 3,113 acres. As shown by Figure III.J-5, the majority of permit applications cluster around the 500 acre average throughout the analysis period, with a slightly increasing trend in average size over time up to 1997. A discernable increasing trend is also present in the upper envelope of permit area size up to 1997. Permit application sizes appear to sharply decrease in 1998.

Figure III.J-3
Trends in Tennessee Permit Application Areas

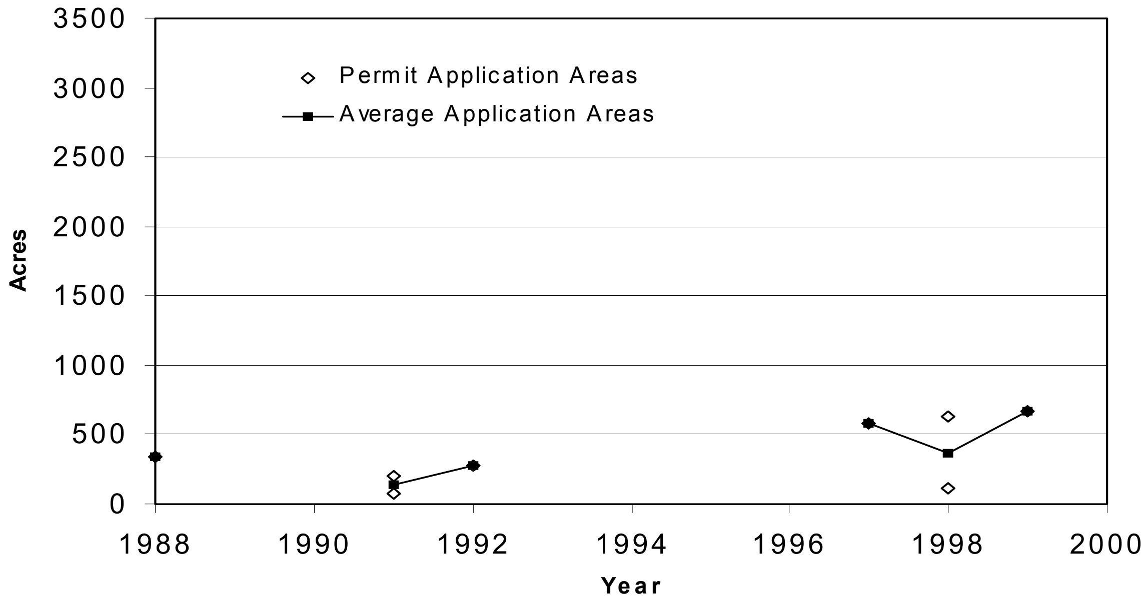


Figure III.J-4
Trends in Virginia Permit Application Areas

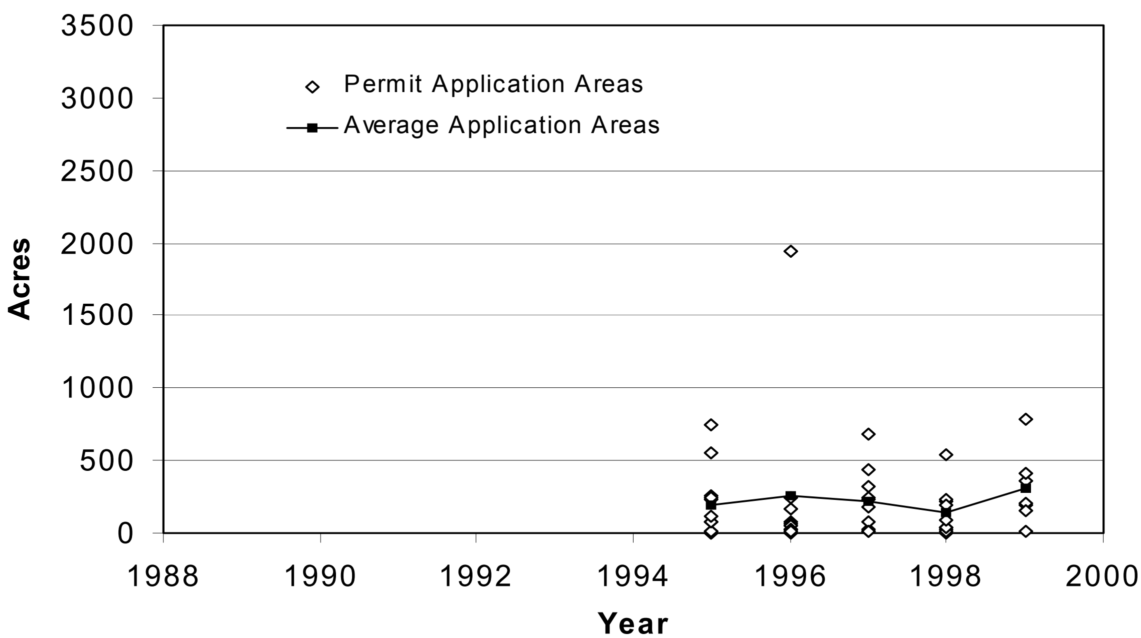
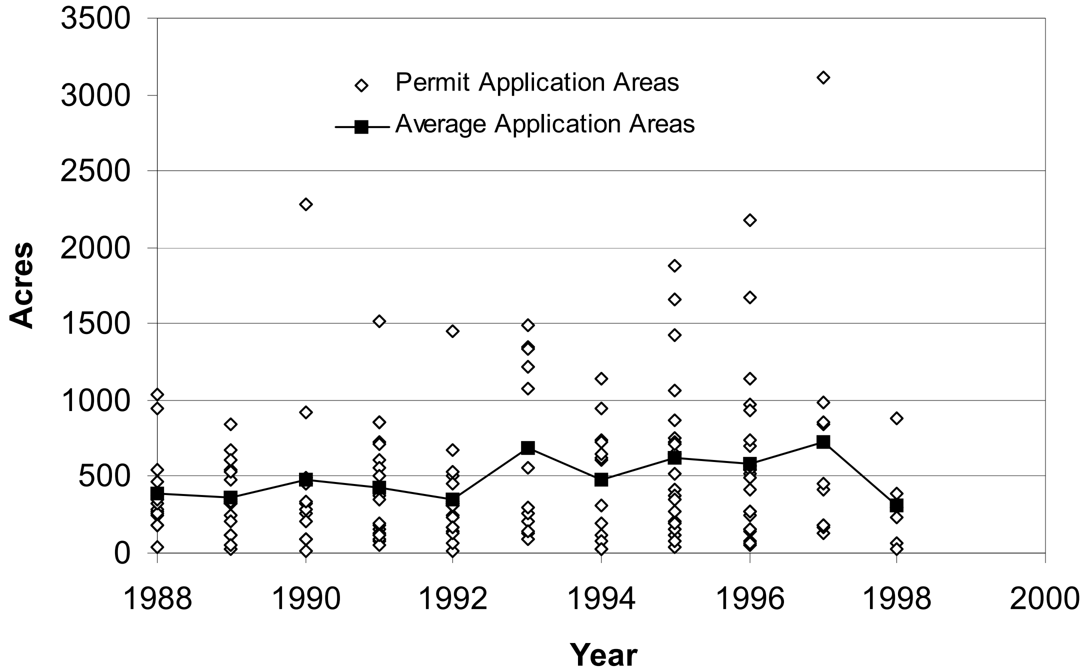


Figure III.J-5
Trends in West Virginia Permit Application Areas



b. Support Facilities

Most MTM/VF mine sites will have at least an office trailer on site to serve as a foreman's office, record and equipment storage, and general meeting point. Temporary sanitary facilities are also fairly common, as a mine site is seldom permanent enough to justify development of in-ground septic disposal systems. On larger sites with long life expectancies, a permanent building may be erected for administration and engineering. However, the corporate administrative headquarters will typically be located off site. Larger sites may also have enclosed garage-type structures for truck and equipment maintenance.

Other buildings that may be present on an MTM/VF mine site include small trailers or sheds, usually mobile to maintain proximity to working areas as mining advances. Trailers or skid sheds are used for storage of parts and supplies, or isolated and used as explosives magazines. Blasting agents, boosters and high explosives, and detonators are stored separately for safety reasons. On large sites, equipment storage may also be provided by the permanent office/maintenance building complex, and explosives may be stored in silos in addition to trailers or sheds.

Small, moveable fuel tanks in the 5,000 to 10,000 gallon range may be located in close proximity to working areas to service mobile equipment. On larger sites, fuel may be stored in a central location and carried to equipment by fuel trucks. A spill prevention plan is required for on-site storage of petroleum fuels, lubricants, and other chemicals used in the mining process.

c. Erosion and Sedimentation Control Facilities

MTM/VF operations employ the standard water diversion ditches found in other types of mine sites, with diversion ditches uphill of disturbance areas and collection perimeter ditches downhill. Because of the long length of the perimeter ditches on large mine sites, these ditches are normally constructed with sediment trapping structures, usually shallow depressions, at intervals along their length. This reduces the sediment load transported to the sedimentation ponds as well as retarding water velocity.

As discussed in Section III.K, valley fills have their own specialized system of erosion control ditches designed to carry a 100-year storm runoff. Groin ditches (located at the intersection of the fill and natural ground) carry runoff from surrounding slopes and the surface of the fill to the toe of the fill and on to the attendant sedimentation ponds. In West Virginia, fills are designed using either groin ditches or center flumes depending on site conditions and company preferences. Both features drain to the attendant sedimentation pond, designed for a 10-year storm runoff.

Under both SMCRA and CWA requirements, all discharges leaving a mine site must pass through a sediment control structure to assure compliance with water quality standards. Sedimentation ponds are constructed below the toe of all valley fill areas and may be used in other areas of a mine where diversion and perimeter ditch flows must be intercepted prior to discharge. Figure III.J-6 displays a typical valley fill toe sediment pond. Sedimentation ponds serve to settle sediment entrained in mine area runoff and attenuate storm surges. Ponds must be designed with sufficient storm surge storage and detention time to prevent violation of the EPA settleable solid standards and be designed to minimize sediment-laden water entering downstream or offsite areas. MSHA regulations place additional permitting and engineering requirements on sedimentation ponds with impounding berms of greater than 20 feet in height or that impound more than 20 acre-feet of water, so sedimentation ponds with large contributary watersheds may be constructed in series to reduce the berm height requirements of the individual ponds.

Drainage from all valley fill areas is required to past through a sedimentation pond, and additional ponds may be present on a mine site where needed to control sediment and runoff from other disturbed areas. Sedimentation control must be in place prior to any disturbance at coal mining sites, but, since mining is not to be permitted where CMD discharges are projected, water treatment systems are not required unless a pollutional discharge develops. When the necessity arises for some form of chemical treatment, the sedimentation ponds are normally used for treatment basins.

Figure III.J-6
Typical Valley Fill Toe Sediment Pond

Source: McDaniel & Kitts, 1999

SMCRA 816.46(c)(1)(ii) requires that sedimentation ponds be located as near as possible to the disturbed area and out of perennial streams, unless approved by the regulatory authority. In practice, the mine operator proposes sedimentation pond locations during the permitting process based on engineering design, drainage course, operational, and construction access constraints. From an operational standpoint, location of sedimentation ponds immediately adjacent to the toe of a fill is not always the most practical alternative. In the case of multiple fills within a drainage course, a single sedimentation pond or downstream pond series may be adequate for drainage from all the fills if located below the discharge from the lowest fill in the drainage course. Narrow valley conditions may also favor placement of sedimentation ponds farther from fill toes in locations where they can be more easily constructed and attain a higher storage volume.

Based on a review of 12 West Virginia mine permit applications having a combined total of 51 valley fill sedimentation ponds, it was determined that over half of these ponds were located within 100 feet of their associated valley fill toes or less, and approximately 90 percent were located within 200 feet of valley fill toes. Greater separation between ponds and valley fill toes occurred primarily where a single pond or pond series was used for multiple fills. These cases ranged between 500 and 1,500 feet of separation. In one case a single pond was identified 3,200 feet from its associated fill toe.

Styles of sedimentation pond construction varied between permits, but most typically involved ponds consisting of a single constructed berm across the drainage below the fill area. In other cases, ponds were constructed across higher order stream drainages receiving discharge from lower order stream with fill area. Several ponds were also outside of a drainage course, constructed by diversion and excavation (called incised ponds). In one permit, up to six ponds in series covered up to 5,200 feet of stream channel. This situation may represent a case where an individual pond sufficient to store a 10-year, 24-hour rainfall event would exceed the MSHA size restrictions. Although observed as proposed in only one of the selected permits, anecdotal information from the WVDEP indicates that this practice of ponds in series is relatively common.

Sedimentation ponds ranged between 150 feet and 5,200 feet (series case) between the toe of berm and end of projected water impoundment. Typical sedimentation ponds averaged placement in about 375 feet of stream, and approximately 75 percent of the reviewed ponds were 400 feet in length or less. Series ponds represented the greatest length of channel occupancy, ranging from 1,600 to 5,200 feet in length. Nine individual ponds were identified with lengths over 400 feet, ranging from 500 to 800 feet. Actual channel occupancy requirements are site-specific, with narrow, low bed-slope channels producing longer impoundment lengths than broad or steep bed-slope channels.

d. Haul Roads

Haul roads within a mine site are constructed to the widths required for passage of vehicles of the size used on that particular operation, and are usually 50 feet or more wide. The overall grade of a haul road normally does not exceed 10 percent for ease of haulage and to minimize brake wear/failure. Lengths of haul roads vary according to the distances necessary to access development, mining, and fill disposal areas. A typical haul road length on an MTM/VF mine site is about 2,500 feet. Ditches are constructed on the uphill sides of haul roads to collect runoff, and culverts placed at intervals to convey runoff under the road to the downhill side. A sediment trap is placed at the inlet to each culvert. Temporary haul roads to working areas are usually surfaced with pit-run crushed overburden materials, while primary haul roads connecting to public roads may be surfaced with gravel or asphalt depending on their permanence and traffic type. Additional small service roads may be constructed to access erosion and sedimentation control facilities or support areas.

3. Mining Equipment

Selection of mining equipment depends on mine design and layout, overburden handling requirements, reserve size, production objectives, cost minimization, and the desire to maximize return on investment (Meikle & Fincham, 1999). Equipment categories are generally divided between heavy equipment used for development and primary production, haulage equipment for spoil and coal transport, and support equipment used for maintenance, and reclamation activities.

a. Production Equipment

Although draglines are often portrayed in association with MTM/VF mines, the majority of MTM/VF operations are contour mines and do not use them. These machines are very expensive and require very large reserves to operate efficiently. Most MTM/VF operations now prefer electric shovels, hydraulic excavators, or large front end loaders for primary production equipment, with shovel/truck combinations predominating (Meikle & Fincham, 1999). Combinations of production equipment and attendant haul trucks are often referred to as equipment *spreads*. Where cast blasting is feasible, large dozers or spoil-side draglines are used for primary spoil movement. Pan scrapers, once used for excavation on smaller sites and contour mines, have virtually disappeared as production equipment. Figure III.J.-7 shows examples of each of the primary types of production equipment in operation.

Relative costs of spoil movement decrease in the following order: overburden loading and haulage, production dozing, dragline movement, and cast blasting. In general, the larger the equipment used, the lower the production cost. However, large equipment is not efficient for mining small areas.

MTM/VF operations will employ more than one type of production equipment to meet different scales of spoil movement within the excavation areas. Meikle & Fincham (1999) provide an example of an MTM/VF operation using shovel/truck, backhoe/truck, loader/truck, and cast blasting/dozer methods on a single site:

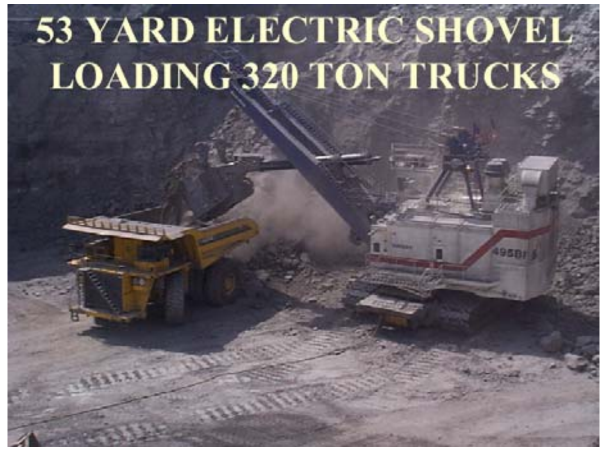
Equipment Spread	Production Rate
25 yard hydraulic shovel	7.5mm BCY/year
18-1/2 yard hydraulic backhoe	5.8mm BCY/year
16 Yard front end loader	4.1mm BCY/year
4 - 54 yard dozers	7.8mm BCY/year

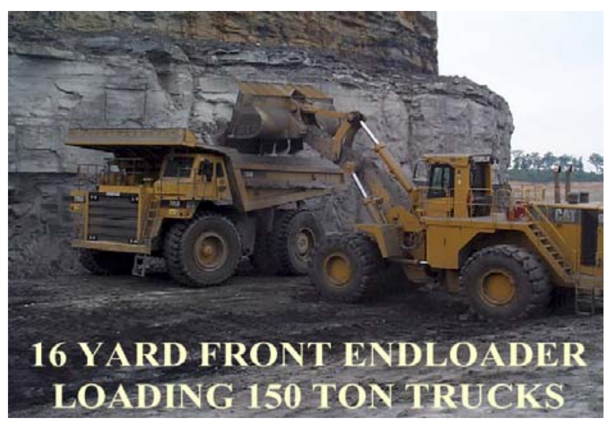
Additional front end loaders and dozers will normally be working in advance of the primary production equipment to mine shallow seams and prepare cut benches for drilling and blasting. Rotary drills are used in conjunction with development equipment for drilling blast patterns on advancing cuts. The ratio of drills to working equipment spreads is approximately 1-1/2 per spread. Drills may be either owned by the coal company but are more commonly leased, as needed. Figure III.J.-8 shows the drilling and loading of blast holes on a bench.

b. Haulage Equipment

Spoil haulage within a mine site is accomplished almost exclusively by off-road trucks, since loaders are not efficient for long transport distances, and shovels and excavators are not efficient for transport outside of their swivel radii. Each piece of production or development equipment will have a set of attendant haul trucks in its working spread. The typical ratios of trucks to equipment are 3-1/2 trucks per shovel or excavator spread, and 2-1/2 trucks per loader spread, with fractional differences shifting between spreads. Shovels and excavators have a larger bucket capacity than loaders and require larger haul trucks, usually in the 150- to 320-ton range. Loaders generally operate with trucks in the 85- to 150- ton range.

Figure III.J-7
Typical MTM/VF Mine Production Equipment





Source: Meikle & Fincham, 1999, and Arch Coal, Inc., 1999

Figure III.J-8
Typical Drilling and Shot Hole Preparation on Bench

Source: Meikle & Fincham, 1999

In addition to overburden haulage, trucks will be present on site to haul the extracted coal to either a processing facility or shipping point. These may be on-road or off-road trucks, depending on the type of road connection, but are usually on-road capable trucks supplied by independent contractors. Contracting of coal haulage is generally cheaper for the coal company by eliminating possession of excess trucks during periods when no production is occurring, and the contractors may service multiple mine sites simultaneously with the same truck fleet. Approximately six contractor trucks will be operating per loader during times when coal is exposed on the pit floor and is being loaded out. A small loader will generally be used for the actual coal extraction and loading at each site. Figure III.J-9 shows a typical coal extraction and loading operation.

c. Support Equipment

MTM/VF operations will have a number of other types of equipment on site in addition to those involved with direct production. These may be engaged in road maintenance, construction of erosion and sedimentation control facilities, clearing and grubbing of mine advance areas, reclamation activities, and general maintenance. The primary workhorse of any surface mine site is the dozer, and about five small support dozers can be assumed for the typical larger MTM/VF mine site. Other types of equipment that are found on a mine site will vary depending on the type and size of operation, but a number are commonly found on all sites and used in the capacities listed below:

Graders – road maintenance
Water Trucks – dust control on haul roads
Lubrication and Fuel Trucks – delivering fuel to equipment
Mechanics Trucks – repair and maintenance of equipment
Bulk Explosive Trucks - delivering explosives to blast holes
4 x 4 Pickup Trucks – transportation for foreman, equipment operators, and laborers

Figure III.J-9
Typical Coal Preparation and Loading in the Pit

Source: Meikle & Fincham, 1999

4. Operational Characteristics

A typical larger MTM/VF mining operation may employ all four of the basic mining methods previously discussed: mountaintop removal, area, contour, and auger/highwall mining. Definitions and methods of reporting for the types of mining methods vary between states, so percentages of utilization for each method cannot be reliably determined. Contour mining is normally limited to development areas or valley fill areas where steep slopes preclude any more extensive extraction. Extent of highwall mining is also variable between sites, but may comprise 20 to 30 percent of the total coal production over the life of a mine site. The following section discusses the operational characteristics of a combined-method MTM/VF mine with emphasis on the development of backfilled spoil profiles and excess spoil disposal in valley fills.

a. Working Areas

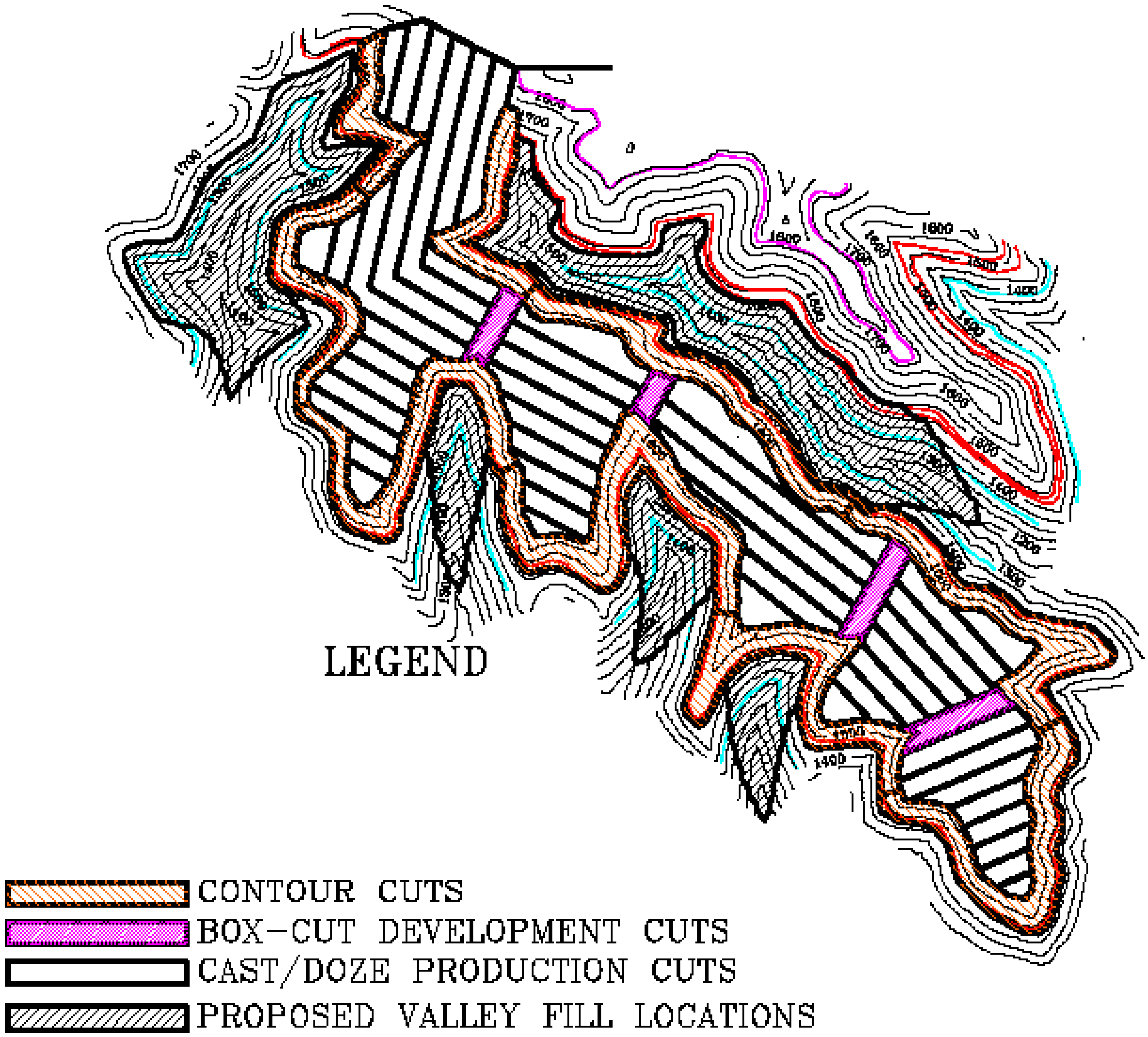
Most larger MTM/VF mining operations are divided between development and production cut mining activities. A typical layout of development and production cut areas that would be used for an MTR operation is shown by Figure III.J-10. Development mining progresses along contour cuts on the outer perimeter of the site slopes and also removes the upper strata from the production cut areas. At intervals, box cuts will be made through the core of the mountaintop or ridge line to open the ends of the production cuts. Production mining then progresses in a back and forth pattern in each production cut area.

The primary goal in mine operation planning is to balance stripping ratios for a reasonably consistent production cost and to prevent equipment from being idled for lack of working areas. Cast blast/dozer operations, in particular, need two working areas at all times for maximum efficiency, such that the dozer fleet can rotate between working areas in the production cuts. After blasting and dozer excavation, it usually takes 2 to 3 weeks to remove the uncovered coal before the next cycle of blasting and excavation can begin in a pit (Meikle & Fincham, 1999). Other production equipment systems, particularly draglines, may be able to progress in a more linear fashion with a single piece of primary equipment.

b. Mining Progression and Backfill Configuration

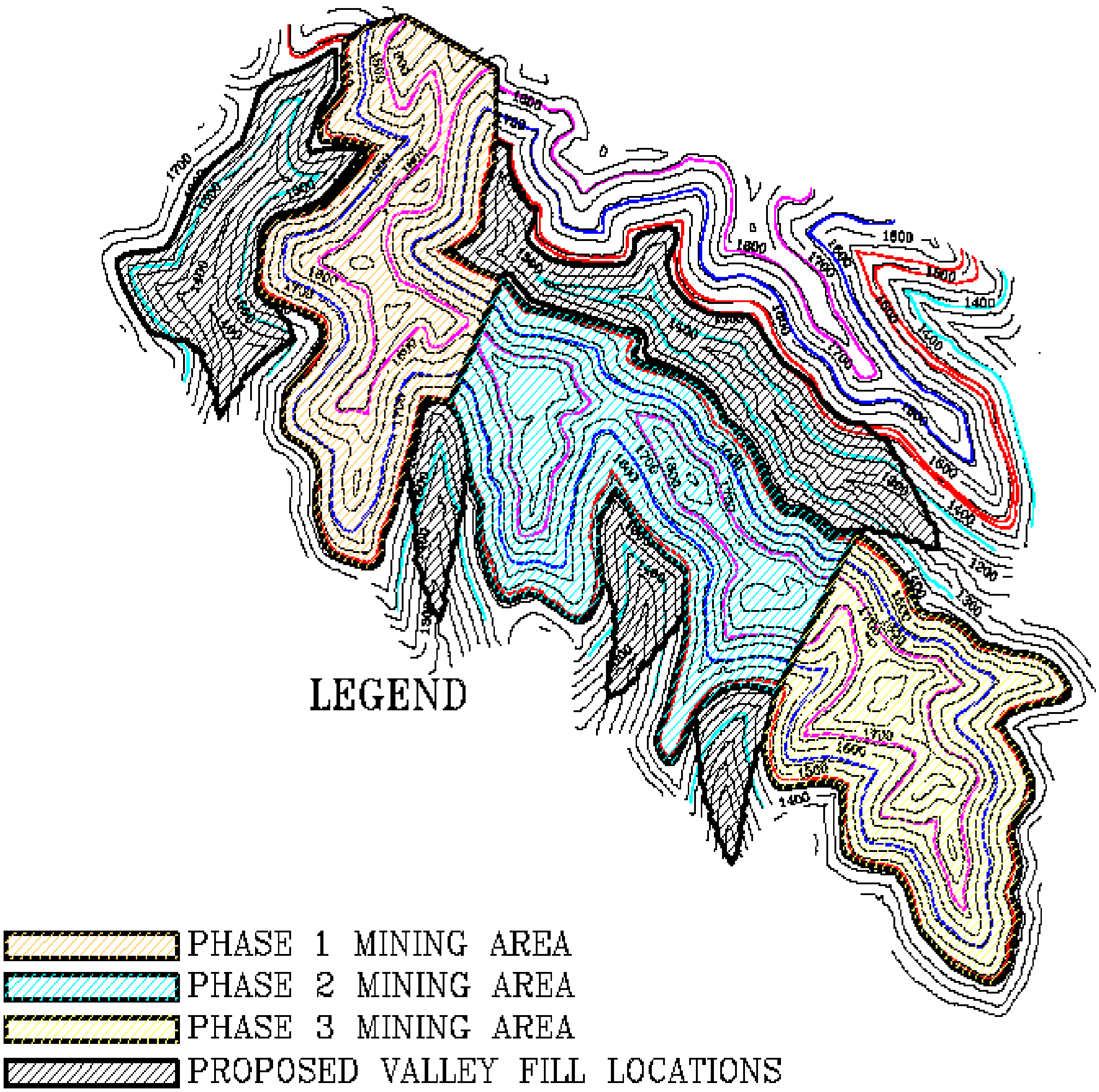
Mining on large MTM/VF sites is usually divided into operational phases. This allows easier planning and presentation of mining and reclamation progression during the permitting process. Figure III.J-11 shows a typical phase layout for the example MTR operation on Figure III.J-10. Note that the first two phases have valley fills along their perimeters, while the third phase does not.

Figure III.J-10
Typical MTR Mine Plan Layout



Source: Meikle & Fincham, 1999

Figure III.J-11
Typical MTR Mine Phase Layout



Source: Meikle & Fincham, 1999

In reference to Figure III.J-11, actual mining will begin at the upper end of Phase 1 with contour and "pre-stripping" cuts immediately adjacent to the two valley fill areas. All spoil from these initial operations will go to the valley fills to make space for spoil from future cuts to be placed on the mine bench. Excavator/truck or loader/truck spreads most commonly work at this stage, with limited dozing production adjacent to the valley fills. Some preliminary mining may take place in the area of the valley fill itself if coal seams are present and accessible for recovery.

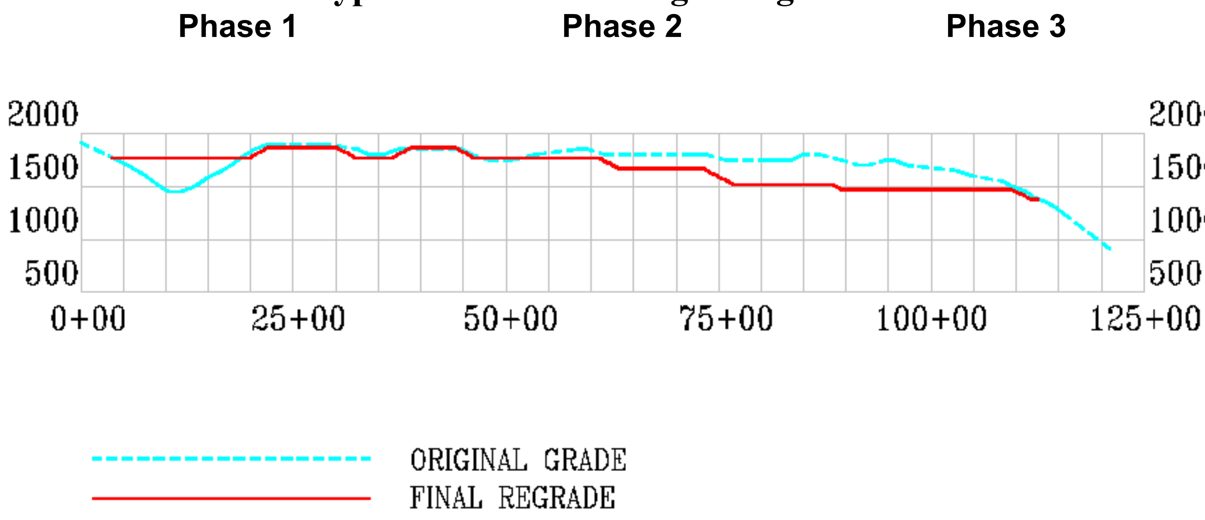
As development activities create the first cut benches in Phase 1, primary production will begin with larger equipment. A progression of cuts will then continue as described in Section III.I.2.b-c towards Phase 2, with development activities continuing in advance of the main production area. Much of the spoil from the ongoing Phase 1 development activities and bench cuts will still go to the valley fills to compensate for excess spoil generation in later areas of the mine.

At a point during Phase 3, a balance will be reached between excess spoil disposal and new spoil generation. By the midpoint of Phase 3, all of the spoil generation will be returned to the mine bench immediately adjacent to the advancing cuts. The latter cuts of Phase 3 are oriented perpendicular to the axis of the ridge to reflect that their spoil will remain on the bench. These cuts will have little overburden remaining after development activities, so their final spoil regrading elevations will be lower than those of the regraded benches in Phases 1 and 2. Thus, the reclamation grade surface will tend to step down from the start of mining to the end. The overall effect of this progressive diminishment of spoil volume and elevation is illustrated by the example MTR regrading profile shown by Figure III.J-12. Because of the movement of spoil to accommodate later stage production cuts, the reclamation elevations of a larger MTM/VF mine site may deviate significantly from the original ground profile and, therefore, may not qualify as AOC. This tends to be the case more on large sites or those with deep excavation of multiple seams than on small sites or those with shallow excavation of fewer seams.

c. Coal Production and Duration

Based on West Virginia permit data, a larger MTM/VF mine will produce approximately 10,000 tons of coal per acre under permit. Production rates can vary considerably over the life of a mine, but a typical mine will produce between 1,000,000 and 2,500,000 tons per year. Permitting of new reserves is ongoing in advance of active permits to maintain mine production at a relatively constant rate. Coal production during the development and primary production phases is chiefly by surface methods. Towards the latter stages of activities in a working area, secondary production by augering or highwall methods may be employed to maximize recovery, after which any remaining reserves in that area are considered to be inaccessible for future production. Secondary mining on true MTR sites (ones where the coal seam is mined from crop to crop in a 360 degree radius) can only occur in those areas that are not MTR.

Figure III.J-12
Typical MTR Mine Regrading Profile



Source: Meikle & Fincham, 1999

The life expectancy of mining in a given permit area varies proportionally to its size. Since MTM/VF mines are usually ongoing projects, the duration of mining on a site will be longer than the life of the individual mine permits covering the site. The typical larger MTM/VF mine site has a total life expectancy of around 10 to 15 years, and may involve a total lifetime production of between 10,000,000 and 40,000,000 tons. Smaller mines with MTM/VF characteristics do occur in single permitted areas with much shorter life expectancies, some lasting only one or two years in active production. Very large sites may allow mining to continue for 20 years or more.

d. Site Reclamation

This section deals primarily with the controls imposed on site reclamation and postmining land uses, and on the methods employed to achieve revegetation on regraded spoil.

d.1. Contemporaneous Reclamation

SMCRA does not have a specific limitation on the area that a mine operation can actively disturb, but does require that reclamation efforts, including backfilling, grading, topsoil replacement, and revegetation, occur as contemporaneously as practicable with mining operations. Larger MTM/VF operations may require large active disturbance areas to allow completion of valley fills, which may have to remain open for extended periods of time to allow completion of coal extraction at multiple bench/seam levels. Multiple working areas may also be necessary to allow efficient cycling of equipment between blasting and excavation areas. A typical larger MTM/VF mine site will have between 300 and 500 acres in active disturbance during its production phase. Reclamation activities follow progressively behind backfilling and regrading operations. Figure III.J-13 shows examples of progressive contemporaneous reclamation.

d.2. Topsoil Replacement/Substitution

Based on permit data, the majority of MTM/VF operations in West Virginia use topsoil substitution for reclamation. Use of topsoil substitutes is usually based on analysis of overburden samples to identify strata with acceptable grain textures to produce a growth substrate. These materials either end up on the surface during spoiling or are placed on reclamation surfaces by dozers following regrading. Mechanical breakdown of the overburden materials into a finer-grained growth substrate occurs during both excavation and regrading.

Both topsoil substitution and topsoil redistribution methods spread the soil materials at a typical thickness of about 4 to 12 inches-although experts in revegetation for reforestation recommend placement of topsoil and the top 10 feet of oxidized overburden/subsoils in a loose-dumped manner to promote rooting and exceptional tree productivity. Topsoil substitution will usually require application of lime and fertilizer, and topsoil redistribution may require these amendments for initially acidic or low-productivity soils. Lime and fertilizer addition rates maybe determined by laboratory testing of surface samples or applied at a constant rate established in the mine permit application. The typical fertilizer application rate is 600 pounds per acre of 10-20-10 or 10-20-20 NPK analysis fertilizer.

d.3. Revegetation Plan

Revegetation usually commences immediately following completion of topsoil or soil substitute spreading and preparation. Species mixes vary considerably depending on the intended postmining land use and the preferences of the coal company or surface owner. Forestland, commercial woodland, and fish and wildlife habitat land uses will be planted with woody species and seeded with herbaceous species, while hayland, rangeland, and postmining development land uses may receive only seeding.

Figure III.J-13
Examples of Progressive Contemporaneous Reclamation

Source: Meikle & Fincham, 1999

Mine reclamation plans typically have two categories of seed mixes: temporary and perennial. Temporary seed mixes are used for temporary stabilization of disturbed areas and stockpiles, and may be applied with the perennial seed mix for initial stabilization of reclamation areas before the permanent cover becomes established. The perennial seed mix may include some annual species, but overall, is intended to produce the permanent herbaceous cover for the reclamation site. Seed application rates vary between 30 and 110 pounds per acre depending on the species mix, but are normally about 75 pounds per acre. Seeding is usually conducted by a hydroseeder, using wood fiber mulch, applied at a rate of 1,000 pounds per acre. Broadcast methods and straw mulch may also be applied at 2,000 to 4,000 pounds (1 to 2 tons) per acre.

Woody species are planted by hand crews or mechanical planting machines prior to or concurrent with seeding activities. Species are typically planted in alternating row groups according to a planting plan map submitted with the mine permit application. Density of planting varies by species, but shrubs typically planted on 5 to 6 foot centers and trees on 8 to 10 foot centers. The total number of woody plants per acre is normally 600 to 700, intended to achieve a survivorship of approximately 450 woody plants per acre. Row planting does not generally produce uniform coverage, and open herbaceous areas are commonly interspersed in the completed site planting layout. The woody species black locust and lespedeza are also introduced by seeding, particularly on the faces of valley fills.

Tables III.J-1 and III.J-2 were developed from a review of twenty West Virginia mine permit applications and summarize the herbaceous (seeded) and woody (planted) species proposed by these applications. These are presented by common and scientific name, category (temporary or perennial for seeding and shrub or tree for planting), relative frequency of use (very common, common, or uncommon), and native status. Native status is interpreted from Reed (1988), Hitchcock (1971), and other sources. Where applied, the term “introduced” refers to species that are not originally native to the study area. It is noted that many of these introduced species have become naturalized to the study area from historic use in agricultural activities.

Table III.J-1
Typical MTM/VF Mine Reclamation Herbaceous Species

Species Name	Category		Application Frequency	*Native Status
	Temporary	Perennial		
Bermuda Grass (*Cynodon dactylon*)		X	U	introduced
Birdsfoot Trefoil *(Lotus corniculatus)*	X	X	V	introduced
Buckwheat (*Fagopyrum spp.*)		X	V	introduced
Clover, Ladino *(Trifolium spp.)*		X	U	introduced
Clover, Red *(Trifolium pratense)*		X	V	introduced
Clover, White *(Trifolium repens)*		X	C	introduced
Fescue, Tall (KY 31) *(Festuca spp.)*	X	X	V	introduced
Foxtail Millet *(Setaria italica)*	X	X	V	introduced
Lespedeza, Bicolor (Lespedeza bicolor)		X	V	introduced
Lespedeza, Kobe (Lespedeza bicolor var.)		X	C	introduced
Lespedeza, Sericea (Lespedeza cuneata)		X	U	introduced
Oats, Common *(Avena sativa)*	X		C	introduced
Orchard Grass *(Dactylis glomerata)*		X	V	introduced
Redtop *(Agrostis alba)*	X	X	C	introduced
Rye *(Secale spp.)*	X		C	introduced
Ryegrass, Annual *(Lolium spp.)*	X	X	V	introduced
Ryegrass, Perennial *(Lolium perenne)*	X	X	V	introduced
Smooth Bromegrass *(Bromus spp.)*	X		U	introduced
Timothy *(Phleum pratense)*		X	U	introduced
Weeping Lovegrass *(Eragrostis curvula)*		X	U	introduced
Winter Wheat *(Triticum spp.)*	X	X	C	introduced
Yellow Sweet Clover *(Melilotus officinalis)*	X	X	C	introduced

V - very common, C - common, U - uncommon
*Reed (1988), Hitchcock (1971)

Table III.J-2
Typical MTM/VF Mine Reclamation Woody Species

Species Name	Category		Application Frequency	*Native Status
	Shrub	Tree		
Autumn Olive (*Elaeagnus umbellata*)	X		U	introduced
Bigtooth Aspen *(Populus grandidentata)*		X	C	native
Black (European) Alder *(Alnus glutinosa)*		X	V	introduced
Black Locust *(Robinia pseudoacacia.)*		X	C	native
Black Oak *(Quercus velutina)*		X	U	native
Black Walnut *(Juglans nigra)*		X	U	native
Chestnut Oak *(Quercus coccinea)*		X	U	native
Chinkapin Oak *(Quercus muhlenbergii)*		X	U	native
Crabapple *(Malus spp.)*	X		V	hybrid
Gray Dogwood *(Cornus spp.)*	X		V	native
Hybrid Poplar *(Populus spp.)*		X	U	hybrid
Japanese Barberry *(Berberis thunbergii)*	X		C	introduced
Pitch Pine *(Pinus rigida)*		X	U	native
Red Maple *(Acer rubrum)*		X	U	native
Red Oak *(Quercus rubra)*		X	U	native
Scotch Pine *(Pinus sylvestris)*		X	C	introduced
Sugar Maple *(Acer saccharum)*		X	U	native
Sumacs *(Rhus spp.)*	X		C	native
Sweet Gum *(Liquidambar styraciflua)*		X	U	native
Virginia Pine *(Pinus virginiana)*		X	C	native
Washington Hawthorn *(Crataegus phaenopyrum)*	X		V	native
White Ash *(Fraxinus americana.)*		X	U	native
White Oak (*Quercus alba*)		X	U	native
White Pine (*Pinus strobus*)		X	C	native
Yellow Poplar *(Liriodendron tulipifera)*		X	V	native

V - very common, C - common, U - uncommon
*Reed (1988), Hitchcock (1971)

K. EXCESS SPOIL DISPOSAL

Excess spoil disposal is a common component of surface mining operations occurring on steep-sloped coal mining sites. Several options are available for disposing of excess spoil, including the valley fills that are the focus of this EIS. Excess spoil may also be disposed of on adjacent pre-SMCRA mining benches, and on adjacent active mine permits and abandoned mine land reclamation projects.

Valley fills offer a means of disposing of excess spoil in the immediate vicinity of its point of generation. The costs of truck haulage of spoil are directly related to haul distance, and from an economic standpoint it is desirable to locate spoil disposal sites as close to the production areas as possible. The impractical alternative would be haulage to a disposal location on another mountaintop or ridge crest. These sites are not available within reasonable haul distances because of topographic or property ownership constraints, and backstacking on undisturbed sites would significantly elevate the land surface and might bury other unrealized coal reserves. Secondary reasons for valley fills relate to equipment operation and postmining land use goals. For production and cost optimization, mining cuts may cross intervening hollows to advance through more than one ridge line at a time, eventually forming a single advancing highwall as the ridge lines merge at the head of the hollow. Movement of equipment between the individual ridge line cuts is greatly facilitated by having the valley fills in place as a travel surface. This is particularly true for walking draglines, which move at a rate of about one mile per day. Equipment relocation would be significantly delayed by less direct routes around the headwaters of a hollow. If agriculture, residential, industrial, or commercial postmining land uses are proposed, it is also desirable to use valley fills to aid in creating the greatest area of usable level ground.

Filling of valleys results in the loss of ephemeral, intermittent and in some cases perennial stream reaches along with their associated aquatic habitats. Toe-of-fill sediment ponds, although normally temporary, also change the habitat and profile of stream valleys beyond the fill itself. Valley fills significantly change the headwater topography of affected streams and can alter surface water runoff and groundwater recharge and discharge patterns. There is also concern regarding long-term fill stability. This section summarizes the principles behind excess spoil generation and disposal practices, and discusses their related hydrologic impacts, stability, and trends in excess spoil generation within the study area.

1. Characteristics of Excess Spoil Generation and Valley Fills

Head-of-hollow fill, valley fill, and durable rock fill are terms used by OSM regulations to describe excess spoil fills placed in steep sloped mining areas [see 30 CFR 816/817.71-74 performance standards; 30 CFR 701.5 definitions, and 30 CFR 780.35 permitting rules]. The common factors between the terms head-of-hollow and valley fill are that the side slopes of the existing hollow or valley measured at its deepest point are greater than 20 degrees, or that the average slope of the profile of the hollow or valley from the toe of the fill to the top of the fill is greater than 10 degrees. A head-of-hollow fill is simply a fill occurring in the uppermost reaches of a hollow, whereas a valley fill is essentially any fill occurring in a hollow or valley downstream of its headwaters. Head-of-hollow fills less than 250,000 cubic yards are required to set the top of the fill level with the coal seam to be mined. Head-of-hollow fills larger than 250,000 cubic yards must set the top of the fill at or near the level of the adjacent ridge line.

Head-of-hollow and valley fills must be constructed in lifts of spoil no greater than four feet in thickness. The face of the fill is thus constructed in stages with a 50% slope and 20-foot terraces at 50-foot intervals. Surface drainage control is provided by a rock core chimney drain for the head-of-hollow fill and by diversions at the junction of the fill and natural ground for valley fills. The terrace surfaces may slope into the fill face at a slope of approximately 1 percent, and towards the center of the fill face at a 3 to 5 percent slope. In these cases, surface runoff from the terraces and fill face may be carried to the toe of the fill by a central rock-lined channel, and from surrounding slopes draining to the fill by side channels known as diversions or *groin ditches*. In other cases, the fill crest and terrace surface may slope towards the sides and discharge via the groin ditches. Both fill types also require installation of sub-drains prior to lift placement in order to control seepage (springs or seeps) and any internal drainage resulting from infiltration of rainfall into the fill mass. An underdrain is typically a sizable ditch, first lined with geotextile or filter fabric, and then filled with graded rock. The filter fabric is then overlapped on top of the rock-filled trench to assure water, but not dirt, silt, or sediment fines, can get into the drain. Underdrains assure desirable low levels of water within the fill and increase stability. These techniques are standard geotechnical practices to assure stability and erosion controls. All excess spoil fills must achieve a factor of safety against mass movement of 1.5.

The head-of-hollow and valley fill method of fill construction was developed to some degree prior to the passage of SMCRA in the mid- to late-1960's because of waste rock disposal practices utilized in Interstate highway construction in West Virginia, and continued throughout the 1970's. Prior to SMCRA passage, controlled excess spoil disposal was not practiced in Virginia, and overburden excavated by mining was typically place/dumped indiscriminately on the out slope below the mining bench. In Kentucky, pre-SMCRA excess spoil fills were typified by a technique of dumping (similar to durable rock fill construction described below, but without the classification of spoil as durable) and subsequent regrading of "angle of repose" excess spoil to a more stable slope. The face of these fills were then benched or terraced. Figure III.K.1-1 shows a typical completed section of a valley fill toe and face parallel to the valley profile. Center drains are typically only used in West Virginia, with groin drains being used in the other states of the study area. Figure III.K.1-2 provides a photograph of these drainage features showing both center drains and groin drains.

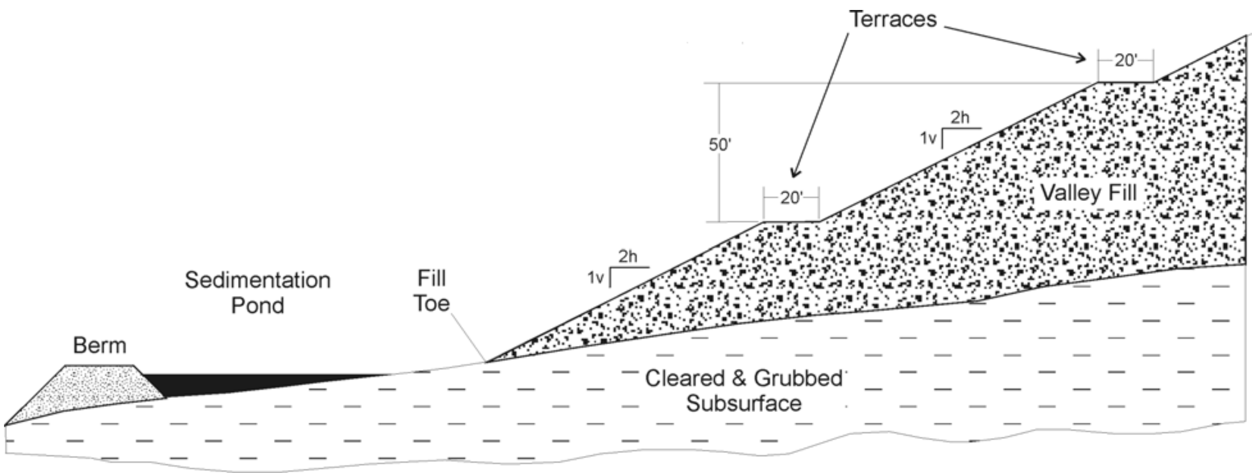
In the late 1970's and early 1980's the durable rock fill method became the predominant excess spoil disposal technique due to the cost efficiencies of the technique. Durable rock fills are the most commonly-constructed type of valley fills and advance from the head of a valley downstream by gravity segregation of dumped *durable* overburden. Durable overburden is classified as consisting of at least 80 percent *durable rock* on a unit volume basis, or rock that can pass certain strength and weathering tests, such as a slake durability test. Durable rock fill construction creates a free face of end-dumped spoil at the angle of repose--which is subsequently regraded when the limits of disposal are reached. The EIS Fill Stability Study [see Appendix H] recorded lifts of existing fills to range between 30 to over 400 feet in thickness. Regrading results in a 2 horizontal to 1 vertical slope ratio with terraces every fifty feet. Surface drainage control is established with the same diversion and groin ditches (100-year storm capacity) as head-of-hollow and valley fills, except West Virginia has a unique state program provision to create a single rock chimney drain to handle all runoff above and on the fill. Internal drainage is assured by the formation of a thick rock blanket drain during end dumping. Figures III.1-3 and III.1-4 show a construction sequence and representative photographs of durable rock fills, respectively.

a. Swell Factor and Excess Spoil Generation

The primary reason for using valley fills is that excavation of overburden results in a greater volume of material than was present on the mine site before mining. When bedrock is broken up forming spoil, void spaces are left between the individual rock fragments, causing them to occupy a greater volume than the original, unbroken rock. This expansion is referred to as *swell* and typically represents a volume increase of about 40 percent. Compaction of spoil during backfilling partially offsets swell as the rock fragments are squeezed together by the weight of overlying material, but this *shrinkage factor* will not completely return the spoil to its solid, or *bank*, volume. The net difference between swell and shrinkage is known as the *bulking factor* of the overburden, which is about 25 to 40 percent for sandstone and 15 to 25 percent for shale (Miekle & Fincham, 1999). Bulking factors vary from mine site to mine site depending on the overburden geology, but the industry average is about 25 percent. In other words, 100 cubic yards of overburden will typically generate about 125 cubic yards of backfilled spoil. Within the mining industry, the term *swell factor* is commonly used in place of the engineering term bulking factor, and will also be used herein. These concepts are illustrated by Figures III.K.1-5 and III.K.1-6.

Particularly on steep-sloped mine sites, the excess spoil generated by the swell factor cannot be completely backfilled on the mine bench without construction of potentially unstable slopes or substantial deviation from AOC. The maximum amount of spoil that can be returned to the mine bench is constrained by SMCRA slope stability and design requirements (i.e, the slope at which backfills can be constructed), perimeter areas occupied by erosion and sediment control structures, as well as access roads.

Figure III.K-1
Typical Profile Section of a Valley Fill Toe

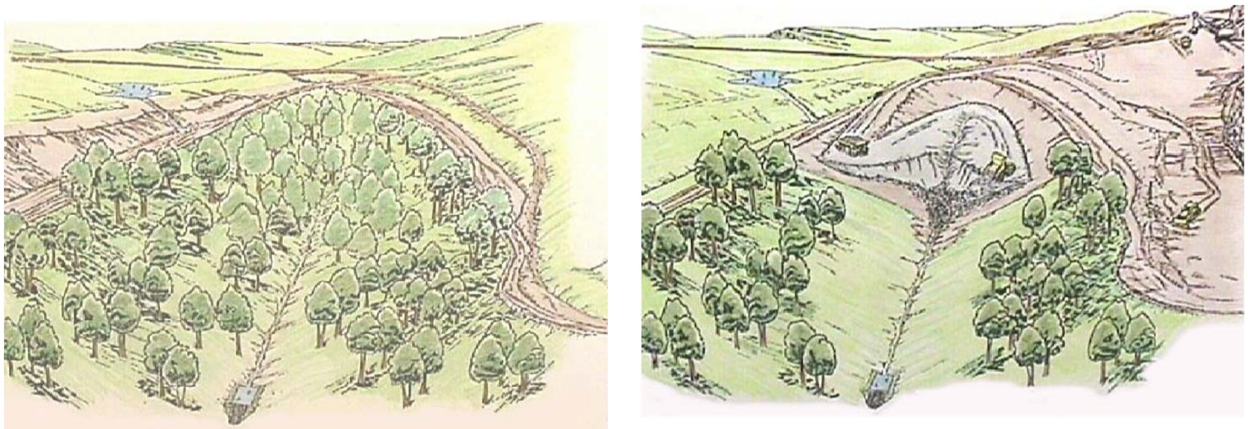


Source: Meikle & Fincham, 1999

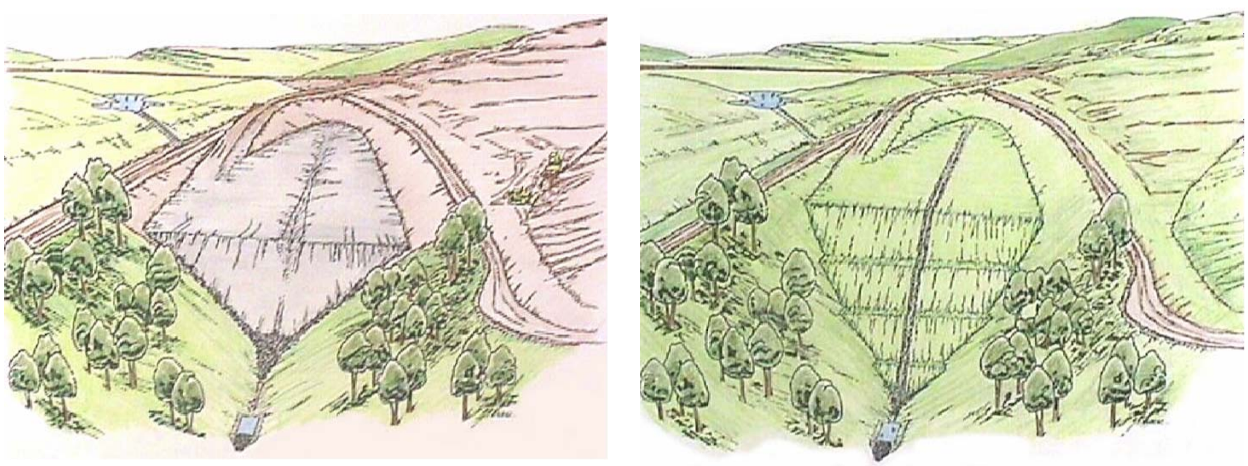
Figure III.K-2
View of Typical Center Drains and Groin Ditches

Source: McDaniel & Kitts, 1999

Figure III.K-3
Center Drain Durable Rock Valley Fill Construction Sequence



(1) Sediment Pond Construction (2) Fill Placement



(3) Completed Fill Placement (4) Completed Regrading/Revegetation

Source: Arch Coal, Inc., 1999

Figure III.K-4
Durable Rock Valley Fill Photographs

(1) Valley Fill Construction

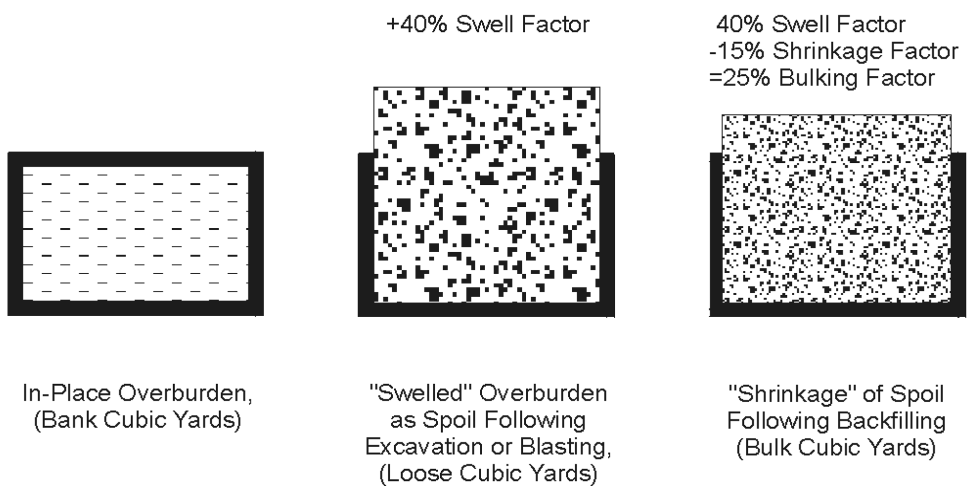
(2) Close-up of End-dump Fill

(3) Completed Regrading

(4) Completed Revegetation

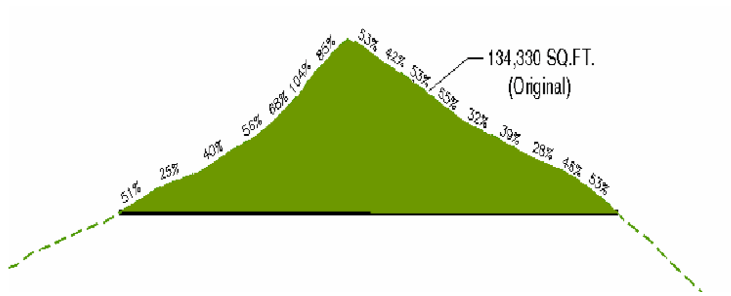
Source: Arch Coal, Inc., 1999

Figure III.K-5
Example of Swell, Shrinkage, and Bulking Factors in Overburden Excavation and Spoil Backfilling

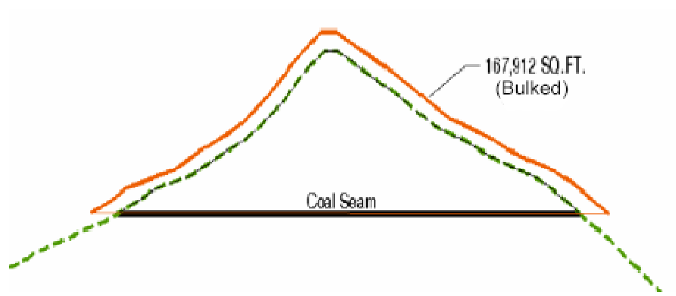


Source: USOSM AOC Presentation

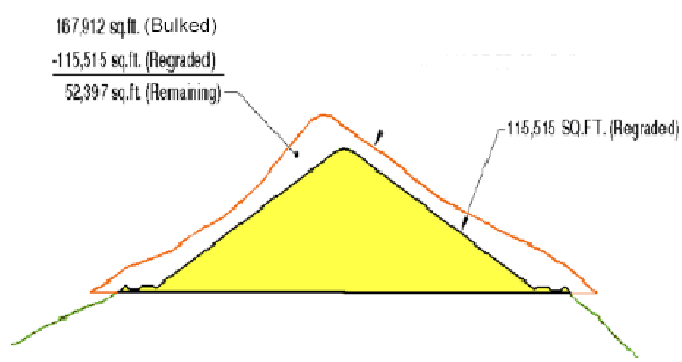
Figure III.K-6
Example of Excess Spoil Generation on a Steep-Slope Mine Site



(1) In-Place or “Bank” Cross Section



(2) Bulked Cross Section



(3) Backfilled Cross Section Showing Excess Spoil

Source: Arch Coal, Inc., 1999

b. Relationship of Valley Fill Construction Technique and Water Quality

Valley fills are required to be constructed from non-toxic spoil materials; therefore, sedimentation is the typical consideration for water quality during their construction rather than chemical impacts. Fills built using the conventional lift-construction method have an advantage for sedimentation control in that they are contemporaneously completed, topsoiled, and revegetated from the toe up as construction progresses. This results in significantly less disturbance upstream of the sediment pond, and requires less frequent cleaning of the pond. Some durable rock fills use a hybrid approach for sediment control by placing several initial lifts at the fill toe location, then end-dumping material progressively toward the toe. This creates a temporary sediment trapping area behind the initial lifts and reduces sediment loading to the downstream sedimentation pond. Sedimentation impacts are primarily a concern for the stream reach between the fill toe and the sedimentation pond, if the pond is not located directly below the fill toe. When a central chimney drain is constructed for the head-of-hollow fill using large boulders, a sixteen-foot wide porous conduit in the center of the fill is created. This chimney core is an excellent sediment trap thus reducing sediment loading to the downstream pond.

c. Valley Fill Stability

There has been anecdotal evidence that valley-fill instability (landslides or land slips on fills) are neither commonplace nor widespread; and, that properly constructed valley fills are well-engineered and stable structures.

The EIS Steering Committee chartered a study of fill stability to corroborate anecdotal perception with empirical information. The complete report is included in Appendix H and is presented on the mountaintop mining website, web address (www.epa.gov/region3/mtntop).

The fill stability investigation evaluated the effectiveness of SMCRA-based regulations through the use of geotechnical indicators of fill stability in the permitting process and in the field. The scope of the study included the identification and analysis of past and existing cases of instability in valley fills in Appalachia. It also included the collection and analysis of indicator data from approximately 120 fills relating to fill designs, present-day construction practices, and the existing conditions of as-built embankments. The fill stability investigation evaluated the current state and federal regulations, policies, and practices; government documents that identify and discuss issues related to the objective of fill stability; and pertinent geotechnical literature. The procedures undertaken by OSM included: (1) discussions with state/federal inspection-and-enforcement (I & E) and permit-review personnel and federal geotechnical experts; (2) review of permits, inspection reports, and other relevant documentation; and (3) aerial and ground-level site inspections.

For the purposes of this study, a fill instability is defined as any evidence that: (1) part of the fill's mass has separated from the rest of the fill; (2) the separation occurs along a continuous slip surface, or continuous sequence of slip surfaces, intersecting the fill's surface; and (3) some vertical displacement has occurred. The instabilities, or "slope movements," identified with these criteria have been further distinguished between critical and non-critical. Critical slope movements are those judged to occur over a large fraction of the fill face (e.g. over at least a few outslope benches) and/or require a major remediation effort (redistribution of the spoil from one part of the fill to another, construction of rock-toe buttresses, extensive reworking or augmenting of the drainage systems etc.). Non-critical cases of instability are those covering a small area on the fill (e.g. not more than one bench on the fill face) and only necessitating minor reworking of the fill material (i.e. without significantly changing the fill's original configuration).

The word "instability" is a general term used in the field of engineering when an engineered construction material or structure fails to remain intact (e.g., without deforming, cracking, or breaking) under stress. For valley fills, commonly used terms descriptive of instabilities include landslide and slip. These types of slope movement are distinguished according to distance and rapidity of material transport. The more dangerous of these is the landslide, which involves sudden, rapid, and relatively distant movement of material. A slip has many features that are similar to a landslide but is characterized by a gradual movement over a shorter distance. Although this type of movement is at first less of a safety hazard compared to a landslide, it can turn into a slide if left unremediated. Both landslides and slips can be considered critical slope movements if they are large enough and costly to remediate. Relatively small events, i.e. non-critical instabilities, are simple to repair. However, if left unattended to, they can become critical.

Although most valley fills occur in relatively remote areas, some of them are above or adjacent to buildings (primarily residential) and public roads. Structures at these locations risk severe damage, if not total destruction, if the fill is not stable. People in or on these structures during a landslide may experience injury.

It is important to note that the danger posed by fill instability is limited in areal extent. Those people or structures on or very close to an unstable fill can be affected. However, catastrophic impacts over a great distance down-valley of a fill instability, as occurred during the Buffalo Creek coal waste dam failure, should not occur. Slope movement on a valley fill would not be expected to impact distant areas because:

- Fill designs build in a substantial, long-term factor of safety against instability and have specific drainage control measures.

- No large quantity of water should be present in properly designed valley fills to "lubricate" the fill material into a flowing mass that could transport for any great distance. The regulations prohibit ponds on fills or fills impounding water behind them. Even improperly-designed fills should have minimal impounding potential.

- Dam failures may release large volumes of water with little or no warning. Fill embankment failures can also be sudden, but are often characterized by the presence of warning signs of instability (cracks, increased seepage, etc.) and a slow creep.

Proper design of stable excess-spoil fill structures is dependent upon accurate characterization of rock strength and durability (30 CFR §816.73). Excess spoil consists of overburden or interburden (soil and rock excavated during the mining operation) not needed to reclaim the disturbed area to the approximate original contour of the land. The excess spoil material forming the rock fill is generally made up of angular blast rock. Before the enactment of SMCRA, excess spoil disposal structures were generally constructed with minimal engineering guidance. Often these structures were placed at locations selected strictly to optimize the mining operation. Since the passage of SMCRA, regulations require increased engineering effort directed toward design and construction of excess spoil disposal areas to improve safety. The fill stability study found only a very small percentage of excess spoil fills that experienced instability over the past 18 years.

2. Trends in Valley Fills

To determine the actual extent of valley fills within the EIS study area, the EIS Steering Committee commissioned a Fill Inventory. The inventory is to develop an accurate, Geographic Information System (GIS)-based database of valley fills constructed or proposed for construction in mining permits. A GIS is queried like any computerized relational database to show statistics about the information in the database, such as valley fill size, numbers, date of construction, etc. As such, the inventory was used to illustrate impacts within the EIS study. The fill data for the inventory were gathered by the states of Kentucky, Virginia, and West Virginia under special efforts funded by OSM and EPA, and gathered by OSM for Tennessee. The inventory was obtained from maps and databases maintained by each of the regulatory authorities. The specific metrics from this study were as follows for each state:

Total number of fills

- Approved each of the years, 1985 through 2001, and cumulatively.
- Fills constructed.

Area of fill "footprint," i.e., fill extent, or acres of ground covered by fill

- Total acreage for the years 1985 through 2001, and by year of permit issuance.
- Range of individual fill footprint sizes for the years 1985 through 2001, and by year of permit issuance.
- Average of individual fill footprint sizes for the years 1985 through 2001, and by year of permit issuance.

Watershed size, or the acres of land upstream, or upslope, of the fill, i.e., between the fill and the ridgetops within each valley

- Total watershed acreage for all fills for the years 1985 through 2001, and by year of permit issuance.
- Average watershed size for each fill for the years 1985 through 2001, and by year of permit issuance.

Miles of stream under fill footprints

- Total miles of 30-acre watershed stream net affected 1985 through 2001, and by year of permit issuance.

The following data were assembled as a part of the inventory effort:

- digital maps of the footprints of the fills,
- acreage of the footprints of the fills,
- volume of fill, if available,
- length of streams covered by footprints of the fills,
- size of the watershed (measured from the toe of the fills),
- permit numbers,
- permit status,
- fill identification numbers,
- current status of each fill (constructed or not), and
- original permit issue dates for each fill.

The scope of the inventory was originally established for fills permitted between January 1, 1982, and December 31, 1999. The initiation date was intended to approximate the dates on which the Secretary of the Interior approved the permanent programs under SMCRA for the states in the study area. The permanent programs went into effect on the following dates: West Virginia on January 21, 1981; Virginia on December 15, 1981; and Kentucky on May 18, 1982. After administering its approved permanent program, Tennessee relinquished its program and a Federal program was implemented on October 1, 1984. Upon approval of a permanent SMCRA program in a state, all existing mining operations had to obtain a new, permanent program permit in order to continue operations. Data from the years immediately following approval of a permanent program in a state show a high level of permitting activity representing this "repermitting" requirement rather than useful information on the trends of permitting new mines. Therefore, the beginning date of June 1, 1985, was established. The ending date has changed to provide more current data for the inventory. As a consequence, the analysis in this section of the EIS will be mostly for the period from January 1, 1985, through December 31, 2001, so as to present valid trend information. There have been several changes in the inventory since the original version was first completed in 1999. First, the inventory now contains data for the years 1999, 2000, and 2001. Second, the additional time has allowed for additional review of the data and several changes have been made because of errors in the original inventory, discovery of fills that were not originally included, and changes in the status of fills and the permits under which they were approved. These changes are minor but they may be confusing to those who received copies of the original inventory report.

An industry practice is to permit more surface area for disturbance than is likely to be affected by the operations planned. This allows the mining operation to respond more quickly to changing market conditions. The rationale is that it's simpler to amend permits to reduce the affected area than it is to increase the affected area. Because of this practice, comparisons are made of the number of fills constructed to the number of fills approved or permitted. For permits where the entire bond has either been released to the permittee (because the site has been fully reclaimed) or has been forfeited (so the site can be reclaimed by the regulatory authority), the number of fills that will be constructed on that permit area is definite because the mining operation is complete. For all other permits, the fills permitted are either constructed or may be constructed because the mining operation is not complete. The reader should note that the proportion of completed fills on newer permits will be significantly less than those on older operations. This is primarily due to the fact that these newer fills just simply have not been built because mining operations have not progressed to the point where they are needed. Also, construction of fills approved prior to 1995 was verified using satellite images, while verification of fills approved after 1995 has been done using data bases that may or may not be updated in the most expeditious manner.

Another common practice is to repermit surface coal mining and reclamation operations using the same facilities, such as valley fills. This happens for a number of reasons including changes in ownership, sale of mining companies, closure and reopening of operations based on market conditions, etc. This practice results in a high number of valley fills being identified under two or more permit numbers. Since the purpose of this inventory was to develop an accurate count of valley fills that actually exist, and not just a listing of valley fills approved under all permits, this practice of repermitting had to be considered. Also, the inventory was to allow its users to have a sense of how valley fills have been approved by the various permitting agencies over time. To account for this, each valley fill was only counted the very first time it was permitted. If the same facility was repermitted, it retained the permit number and issue date of the original permit. Most state regulatory agencies and OSM maintain inventories and data bases of valley fills approved by permits. Since this results in each valley fill being included every time it is repermitted, these inventories will seldom correspond on a one to one basis with the inventory presented in this report.

This inventory was an attempt to identify fill structures placed in valleys or heads-of-hollows. It includes fills approved or constructed on all surface coal mining and reclamation operations including mountaintop removal operations, contour and auger mining operations, underground mine face ups, processing and loading facilities, preparation plants, roads, or any other facility that had to make use of a spoil or refuse disposal site in order to operate. No distinction was made between spoil or refuse fills. Impoundments were added whenever such information was made available. This was done in order to provide as complete an inventory as possible and to accurately reflect field conditions. The majority of the fills are permitted as part of surface mining operations. Of the 6697 fills counted in this inventory, 5688 (85 percent) are on surface mining operations, 719 (11 percent) are on underground mining operations, and the remaining 290 (4 percent) are on other types of operations such as preparation plants, tipples and load-outs, or other types of facilities. It is assumed that all the files on surface mining operations and most of the fills on underground operations are spoil fills. If is certain that a fair percentage of the fill structures on some underground mines and most of the other types of operations are refuse fills or impoundments.

The data for the inventory are fairly complete and allow for meaningful analysis of trends. Reliable information on the permitted fill volume is generally not available except in the individual permitting documents, and was not analyzed. Stream measurements were estimated from a stream network derived using a flow accumulation model over the National Elevation Data set (NHD), and based on draining a minimum watershed size of 30 acres. The digital “hydrography layer” of a USGS 7.5-minute topographic map consists of two line types--a solid blue line (representing perennial stream segments) and a broken blue line (representing intermittent stream segments). Delineation of the two stream types on USGS 7.5-minute topographic map was highly subjective, and followed no standard qualifying criteria. The synthetic stream net is objective and remains more consistent across State boundaries than the anecdotal evidence of a USGS 7.5-minute topographic map. Measurements for ephemeral stream segments were not available and are not included in this section. The inventory has been developed in GIS using ArcView as the base program for mapping and data analysis. OSM is looking into the feasibility of making the map coverages and data used for this analysis available on its web page located at http://www.osmre.gov.

The following figures show the extent of the entire study area and provide a visual indication as to the level of valley fill construction in the states within the study area.

Figure III.K-7: Overview of the Valley Fill Inventory Study Area

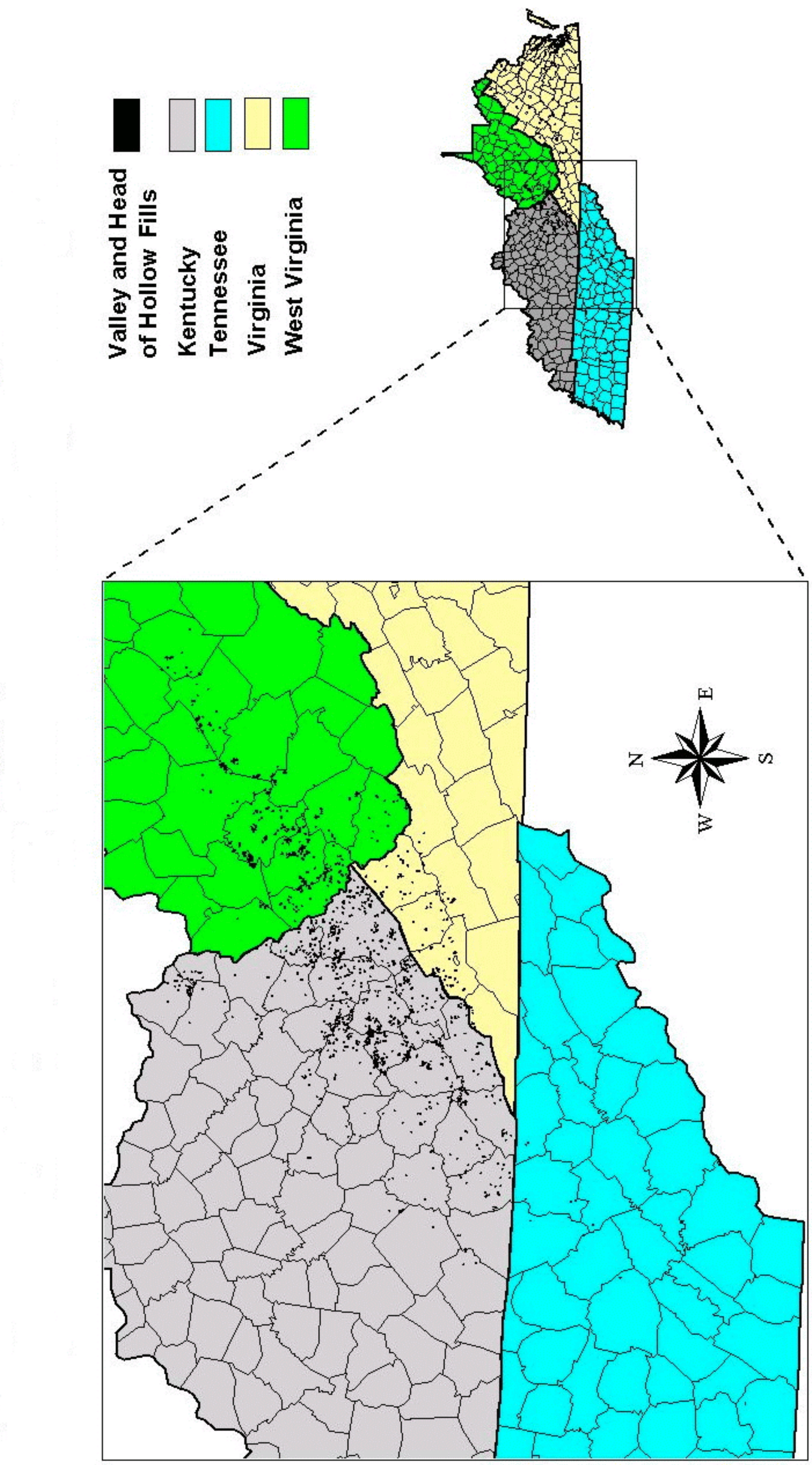


Figure III.K-8: Kentucky Fill Inventory Study Area

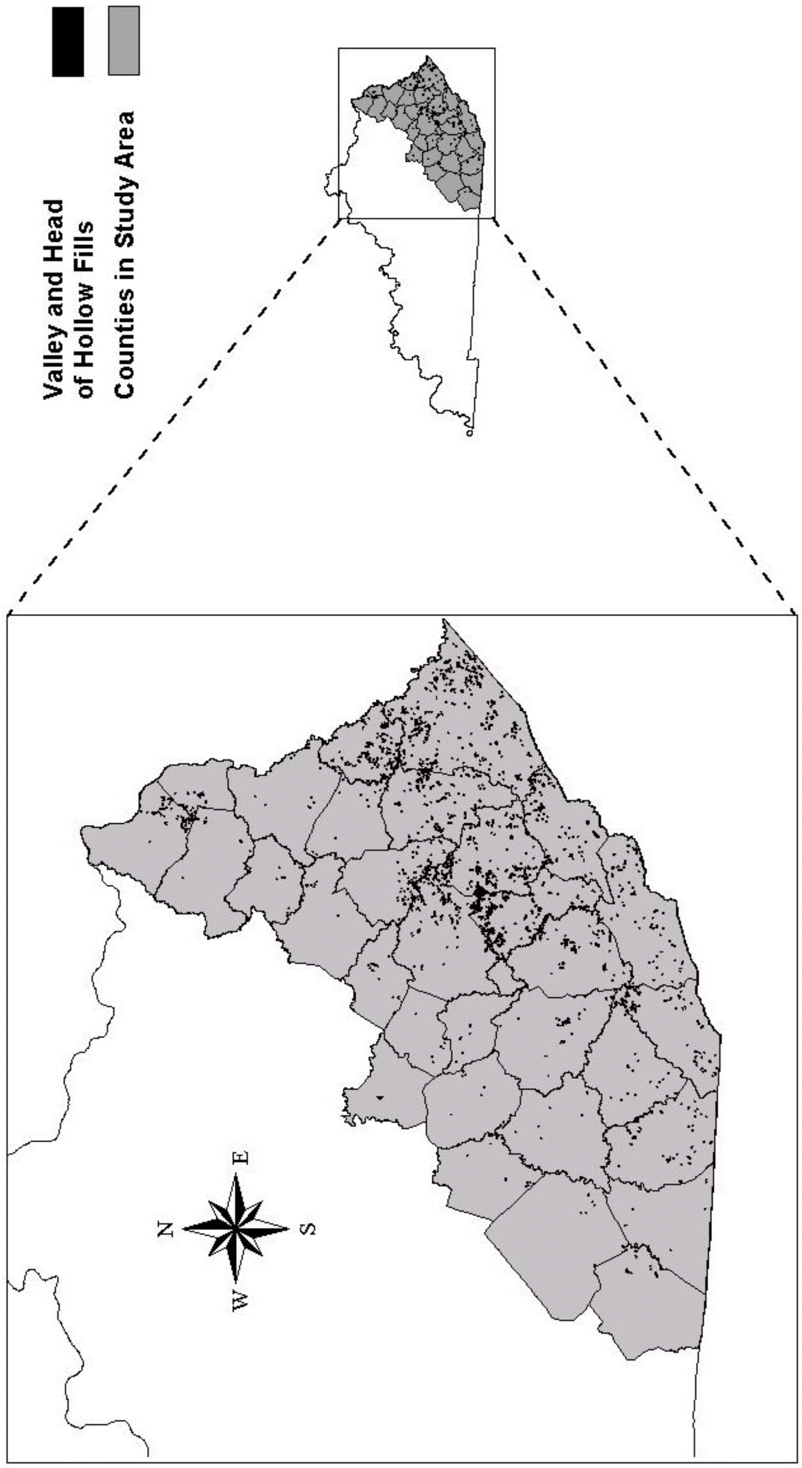


Figure III.K-9: Tennessee Fill Inventory Study Area

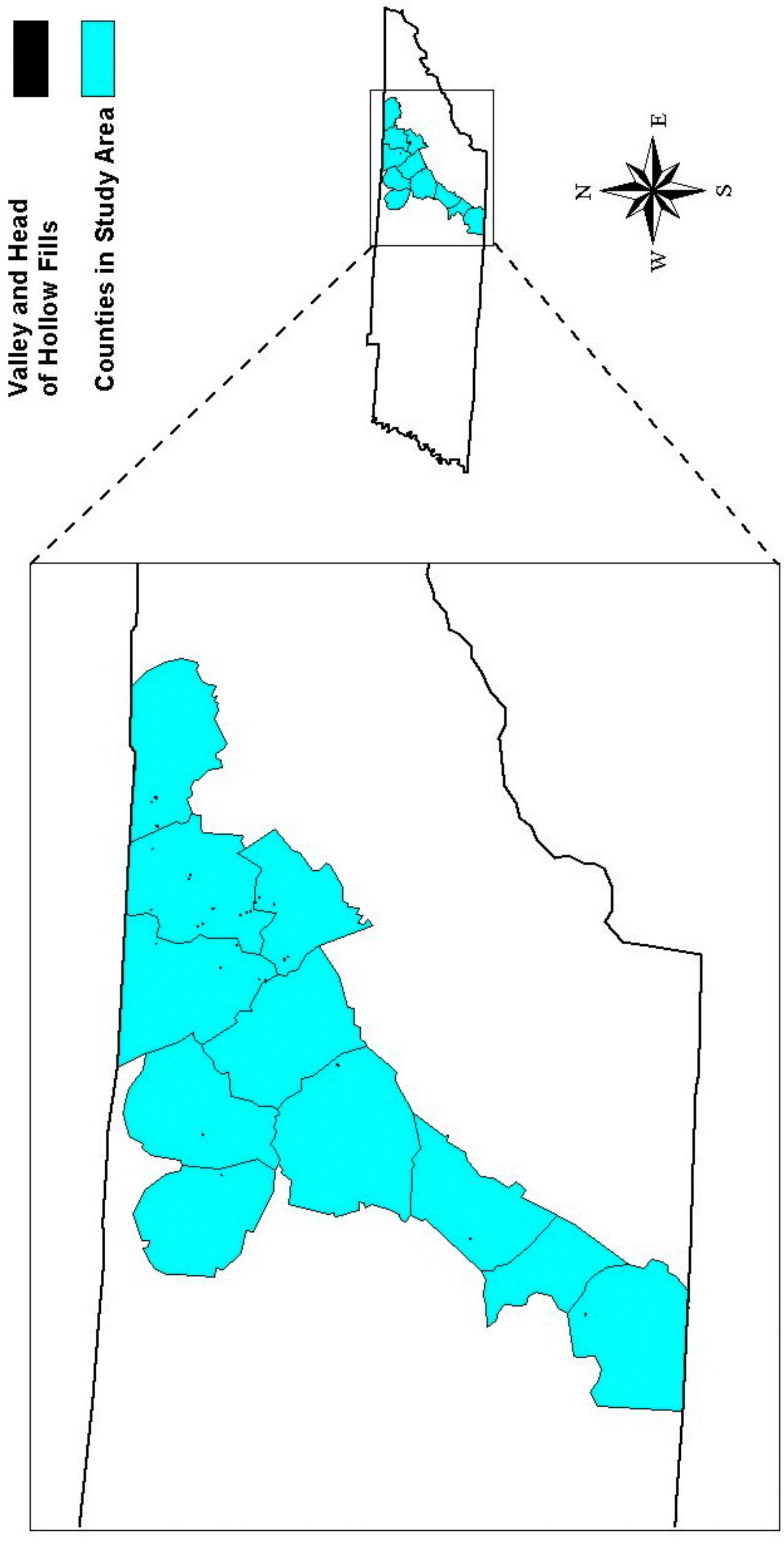


Figure III.K-10: Virginia Fill Inventory Study Area

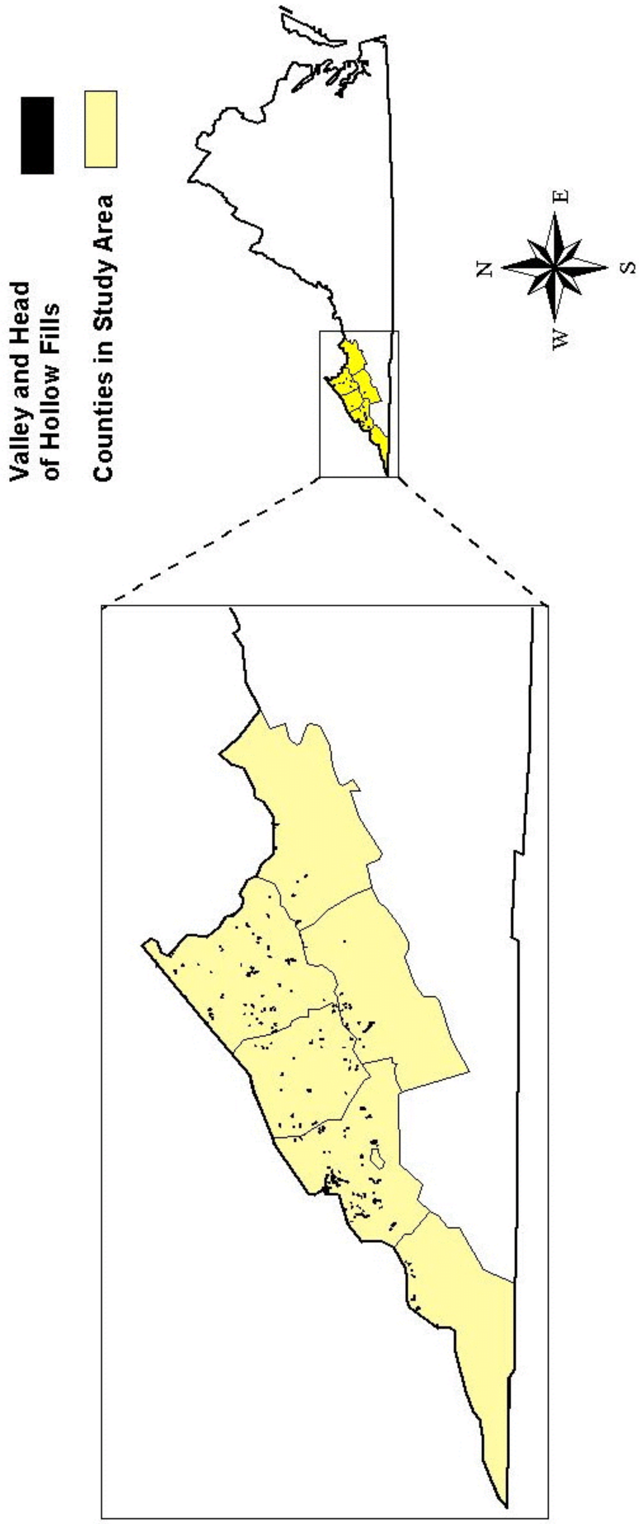
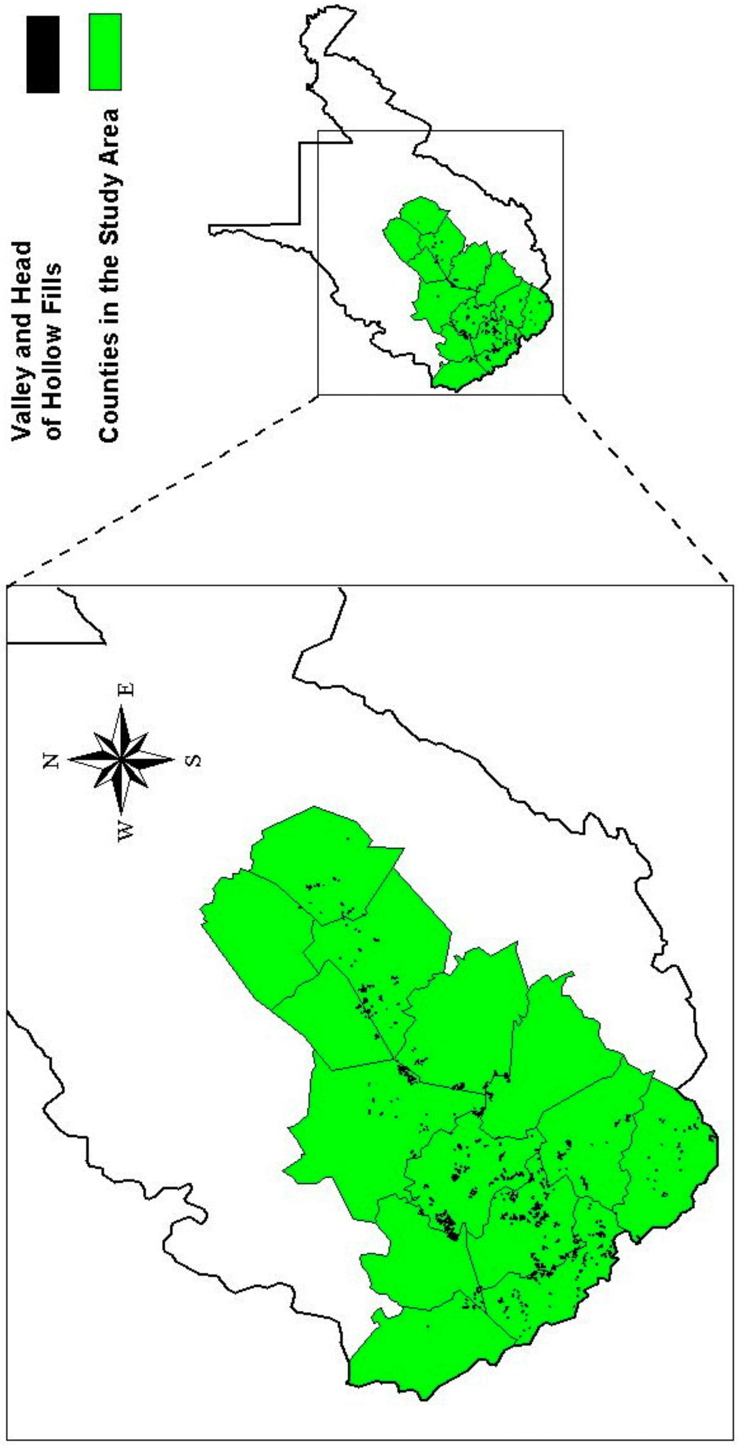


Figure III.K-11: West Virginia Fill Inventory Study Area



a. Regional Valley Fill Trends

Figure III.K-12 is the number of valley fills approved in each of the states contained in the study area for the period from 1985 through 2001. A total of 6697 valley fills were approved during this period.

Figure III.K-12 Total Number of Valley Fills Approved in States and Region

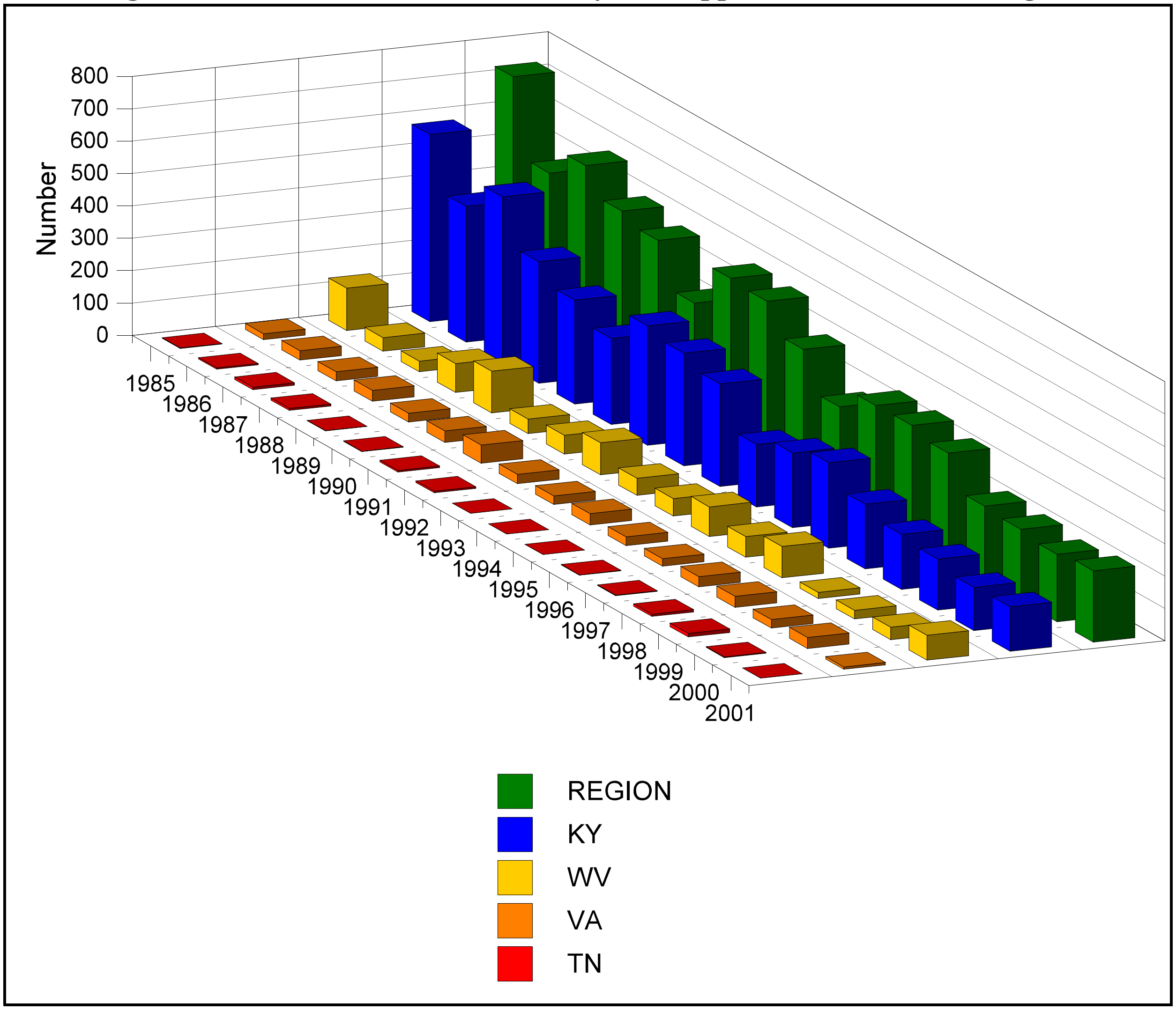


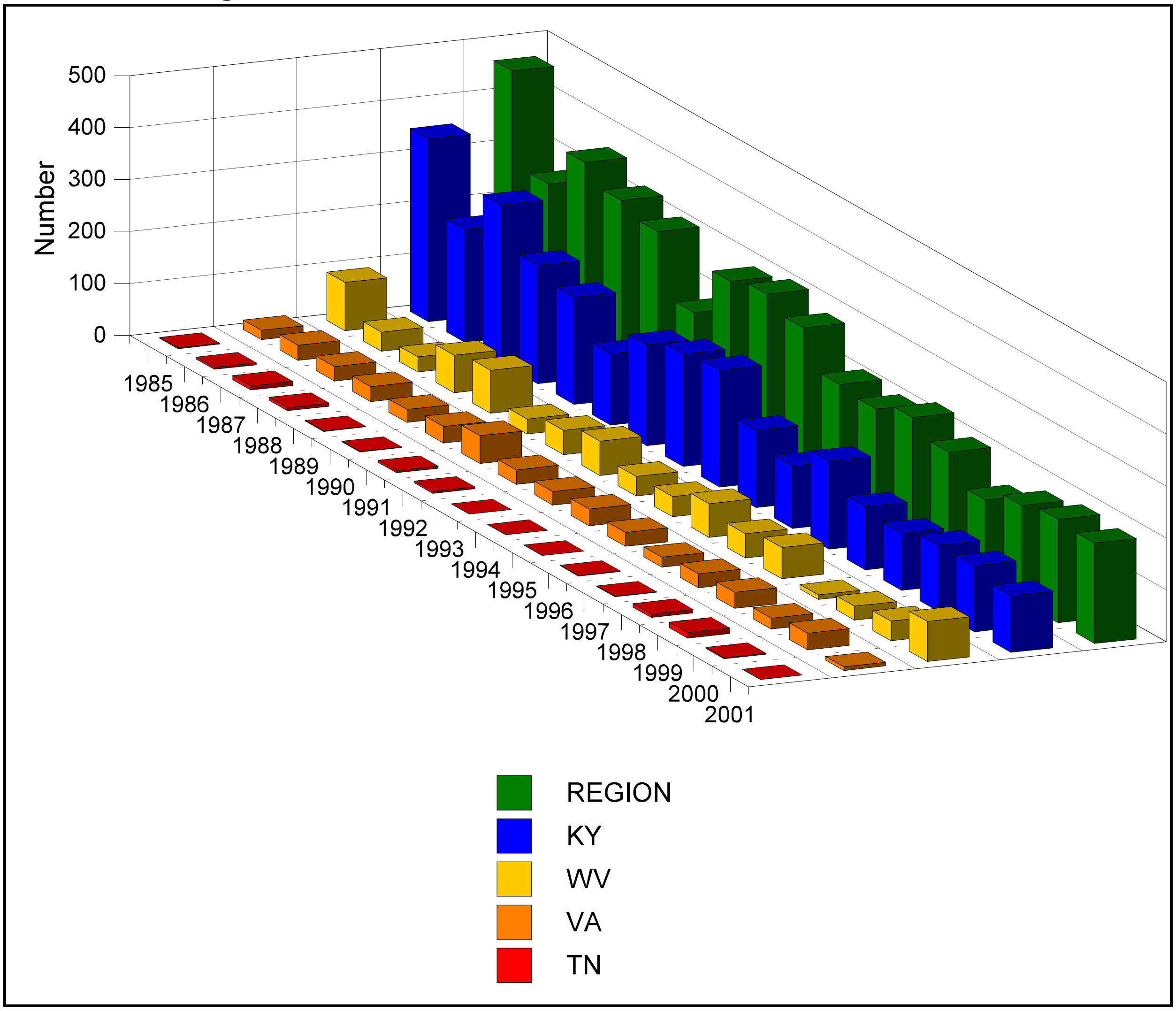
Table III.K-1 provides yearly data for the number of valley fills approved in states contained in the study area.

Table III.K-1
Valley Fills Approved in States and Region

Year	Kentucky	Tennessee	Virginia	West Virginia	Region
1985	578	2	18	131	729
1986	420	4	29	42	495
1987	513	8	28	33	582
1988	376	6	34	89	505
1989	321	1	27	129	478
1990	266	1	36	45	348
1991	369	5	56	58	488
1992	348	5	29	99	481
1993	317	0	26	53	396
1994	193	0	35	54	282
1995	231	0	27	92	350
1996	264	1	23	64	352
1997	200	2	31	97	330
1998	170	7	34	19	230
1999	158	11	26	27	222
2000	134	2	34	38	208
2001	137	0	7	77	221
Total	4995	55	500	1147	6697

Figure III.K-13 is the number of valley fills that were constructed or may be constructed in each of the study states for the period from 1985 through 2001. A total of 4484 (67 percent) valley fills out of the 6697 approved were constructed or may be constructed.

Figure III.K-13 Trends in Valley Fills Constructed or Proposed to be Constructed by States and Region



b. Kentucky Valley Fill Trends

During the period from 1985 through 2001, a total of 6,446 new permanent program permits were issued in Kentucky (OSM's Annual Reports from 1985-2001). Of these, 3,837 were new permits within the study area. The other 2,609 were in western Kentucky, were issued under the now repealed two-acre exemption, or were transfers or successions of existing operations. (SMCRA originally exempted any operation affecting 2 acres or less from requirements to comply with the standards of the Act. Most states still required permits on such sites and required reclamation to state standards. Due to widespread abuse of this provision, the 2-acre exemption was repealed in 1987.) Within the study area, 2,404 permits were issued without valley fills, and 1433 permits were issued with 4995 valley fills. Four thousand one hundred and thirty seven (4137) fills were approved on 961 surface mines, 738 were approved on 393 underground operations, and 120 were approved on 79 operations of other types (preparation plants, refuse fills, roads, tipples, etc. Figure III.K-14 shows that the number of permits issued, with or without valley fills, generally decreased through the period. During the period from 1990 through 2001, the number of permits (with or without valley fills) decreased 54 percent. Figure III.K-14 also shows that the number of fills decreased 48 percent during this same period. Including all permits issued, an average of 1.79 valley fills per permit was approved for the period 1990 through 2001. For permits containing approved valley fills, the average number of valley fills per permit was 3.6 for this same period. The range of valley fills issued per permit for the same period was zero to 31.

Figure III.K-14 Total Number of Fills Approved in Kentucky

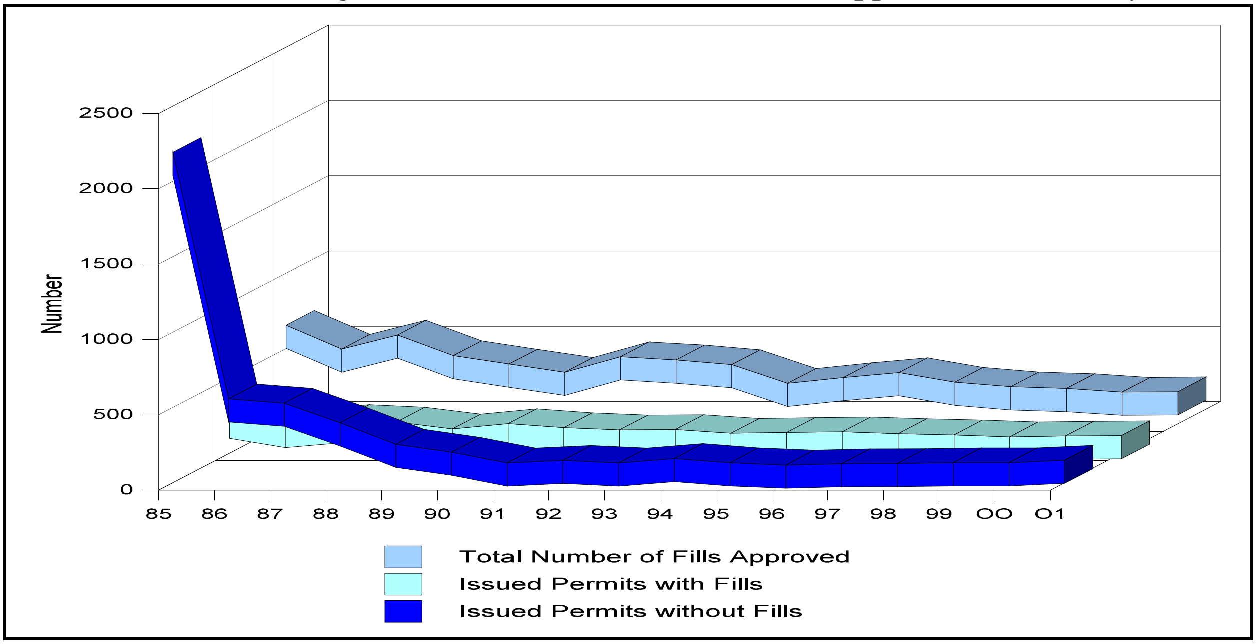
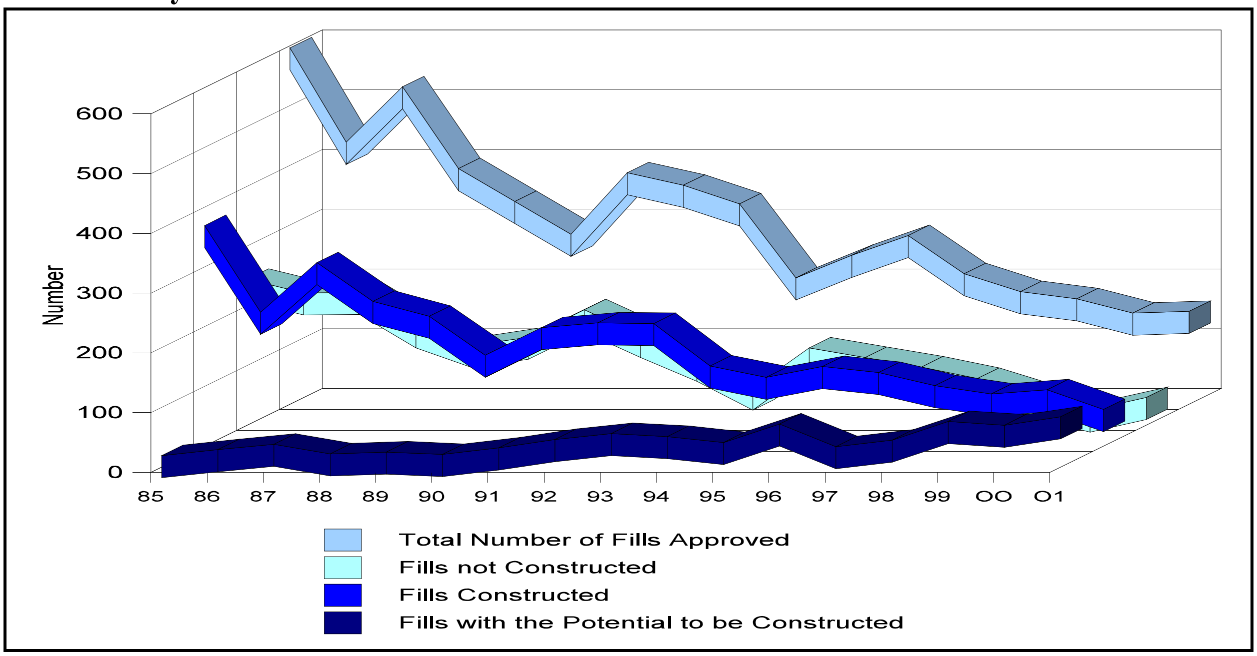


Figure III.K-15 shows trends in Kentucky valley fills constructed, or that having the potential to be constructed due to ongoing mining activity, during the period from 1985 through 2001. A total of 3117 (62 percent) of the 4996 approved valley fills are either constructed or may be constructed. The other 1879 valley fills will not be built because the bonds have either been released or forfeited for those permits.

Figure III.K-15 Trends in Valley Fills Constructed or Proposed to be Constructed in Kentucky



c. Tennessee Valley Fill Trends

Tennessee had a relatively small number of permits issued with valley fills. These limited data inhibit a trend analysis. Nonetheless, trends have been prepared for comparison to the other states. During the period from 1985 through 2001, a total of 236 new permanent program permits were issued in Tennessee (OSM's Annual Reports from 1985-1999). Thirty-five permits were issued with 55 valley fills. The other 201 permits were approved without valley fills. Figure III.K-16 shows that the number of permits issued with or without valley fills varied slightly during the period from 1985 through 2001, with one exception. An anomaly involving an increase in the number of valley fills was noted in 1999. This anomaly is related to one permit with nine valley fills that was issued in 1999. The average number of valley fills issued per permit is 0.62. The range of valley fills issued on permits is zero to nine.

Figure III.K-16 Total Number of Valley Fills Approved in Tennessee

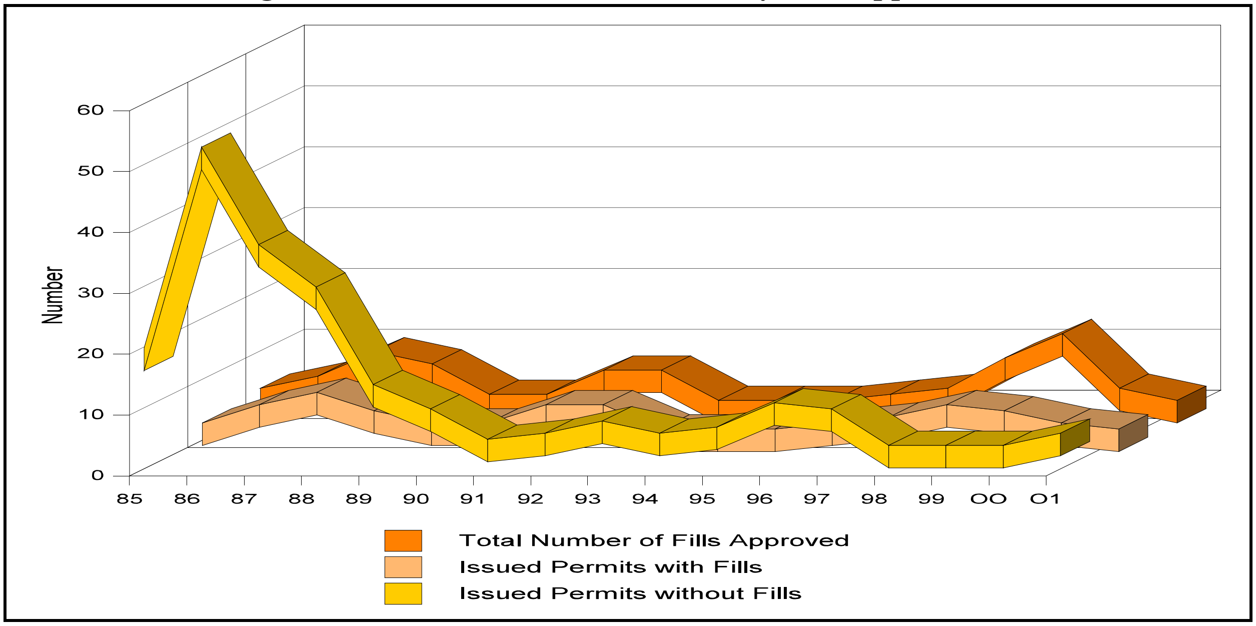
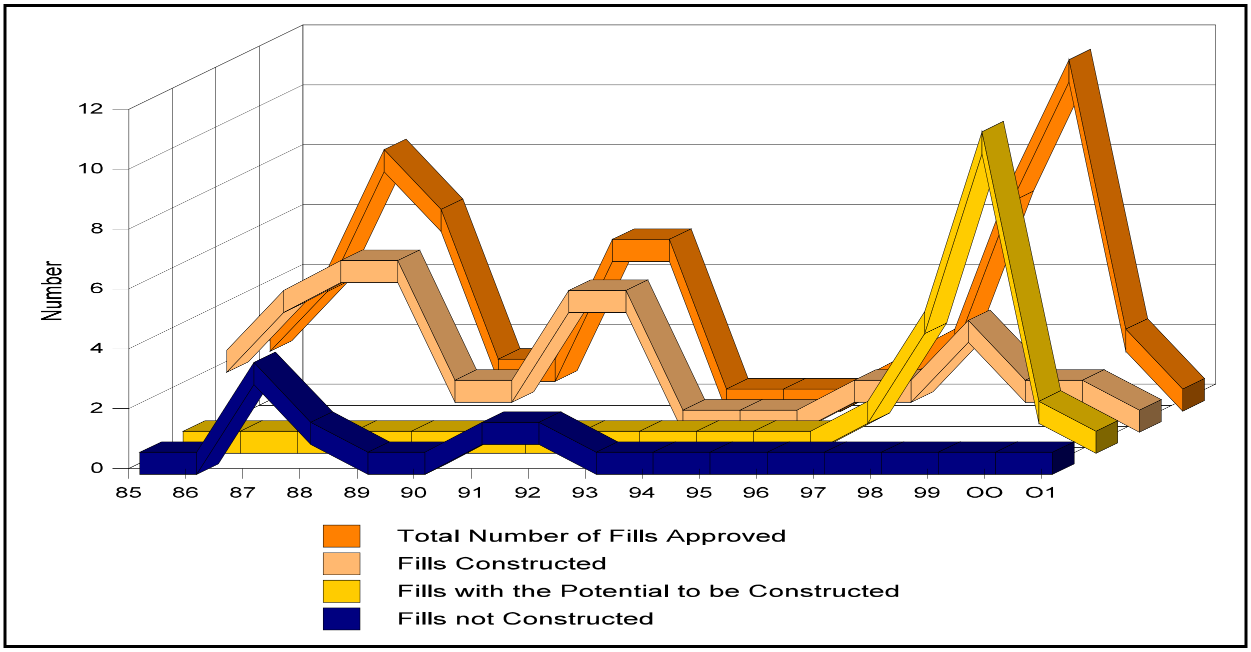


Figure III.K-17 shows trends in valley fills constructed or having the potential to be constructed in Tennessee during the period from 1985 through 2001. A total of 48 (87 percent) of the 55 approved valley fills are either constructed or have the potential to be constructed. The other seven valley fills will not be built.

Figure III.K-17 Trends in Valley Fills Constructed or Proposed to be Constructed in Tennessee



d. Virginia Valley Fill Trends

During the period of 1985 through 2001, a total of 916 new permanent program permits were issued in Virginia (OSM's Annual Reports from 1985-2001). Of these, 194 were issued under the now repealed two-acre exemption or were transfers or repermits of existing operations leaving 722 permits where permanent program standards would have applied to valley fills. Of these 722 permits, 493 were issued without valley fills, and 229 were issued with 500 valley fills. Three Hundred and thirty valley fills were approved on 123 surface mines, 45 were approved on 39 underground operations, and 125 were approved on 74 operations of other types (preparation plants, refuse fills, roads, tipples, etc.) Figure III-K-18 shows that, during the last ten years, the number of permits and valley fills issued each year have remained relatively consistent throughout the period with a few deviations. An average number of 2.7 valley fills per permit was approved for the period 1990 through 2001. The range of valley fills issued on permits for the same period is zero to 11.

Figure III-K-18 Total Number of Fills Approved in Virginia

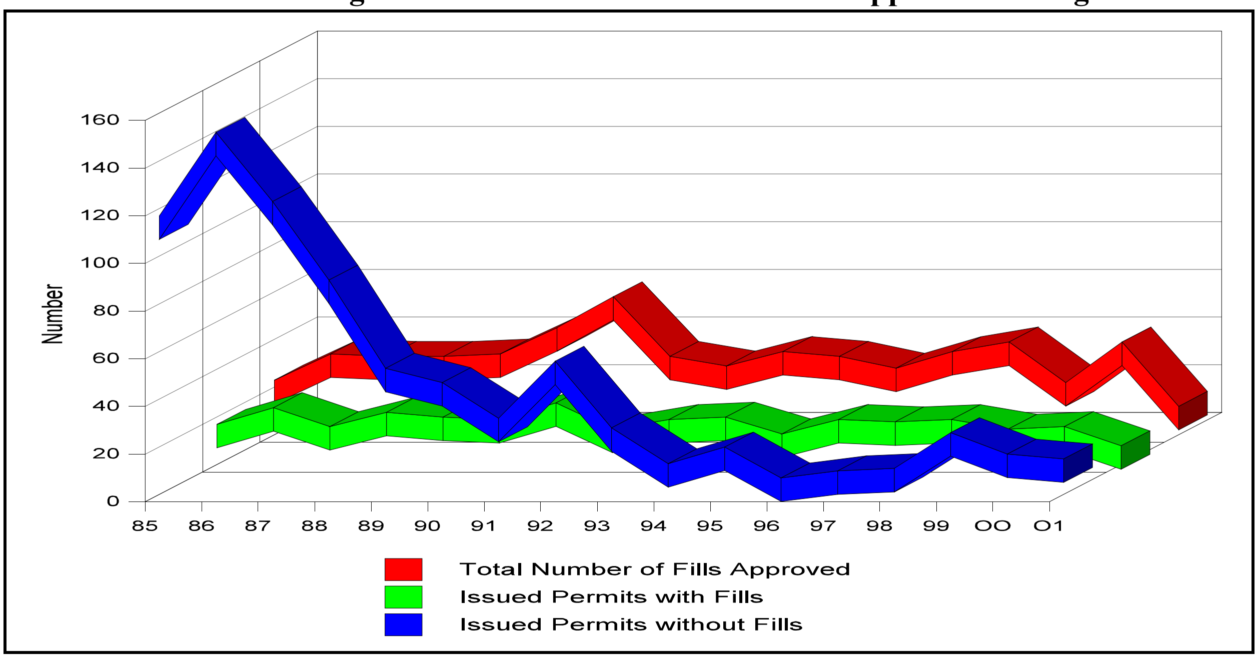
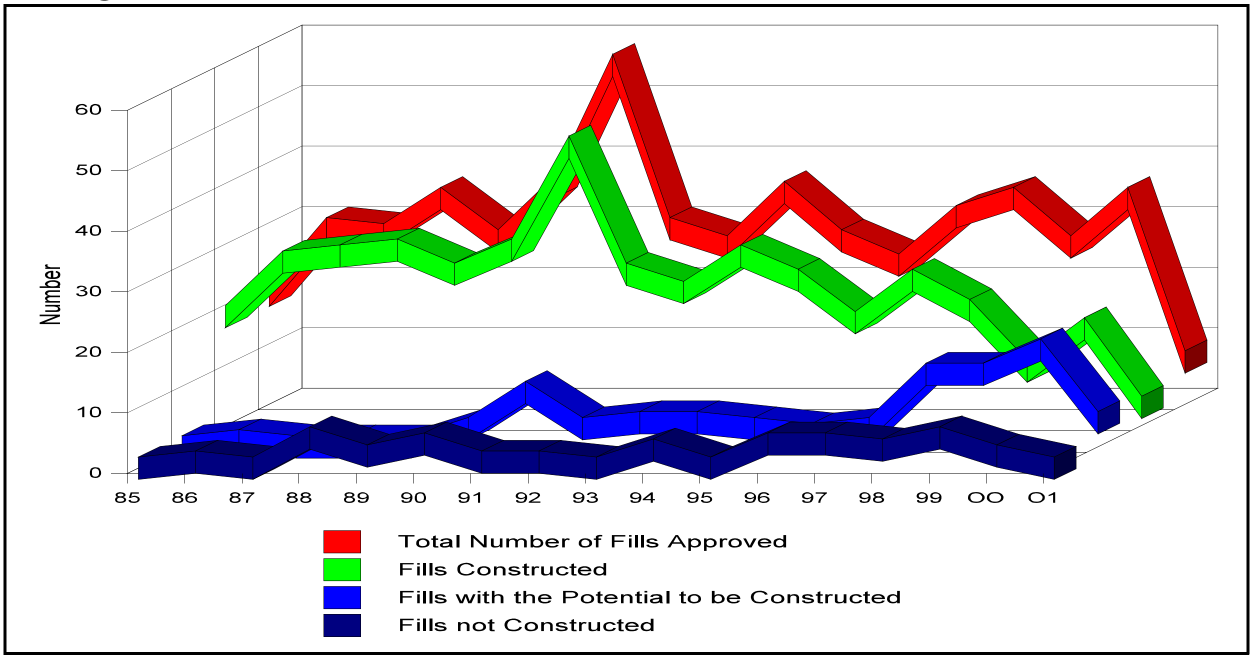


Figure III.K-19 shows trends in valley fills constructed, or that having the potential to be constructed due to ongoing mining activity, during the period from 1985 through 2001. A total of 465 (93 percent) of the 500 approved valley fills are either constructed or may be constructed. The other 35 valley fills will not be built because the bond has either been released or forfeited for those permits.

Figure III.K-19 Trends in Valley Fills Constructed or Proposed to be Constructed in Virginia



e. West Virginia Valley Fill Trends

During the period from 1985 through 2001, a total of 2,639 new permanent program permits were issued in West Virginia (OSM's Annual Reports from 1985-1999). Three hundred and forty two (342) permits were issued with 1147 valley fills. The other 2,297 permits were approved without valley fills. Figure III.K-20 shows marked variability during the period from 1985 through 2001. The figure suggests a decrease in the number of permits issued without valley fills, while the number of permits issued with valley fills has varied during the period. Figure III.K-20 also shows that the number of fills decreased during the period from 1990 through 2001 from a high of 91 fills in 1995 to a low of 19 fills in 1998. An average of 0.6 valley fills per permit was approved for the period 1990 through 2001. The range of valley fills issued on permits for the same period is zero to13.

Figure III.K-20 Total Number of Valley Fills Approved in West Virginia

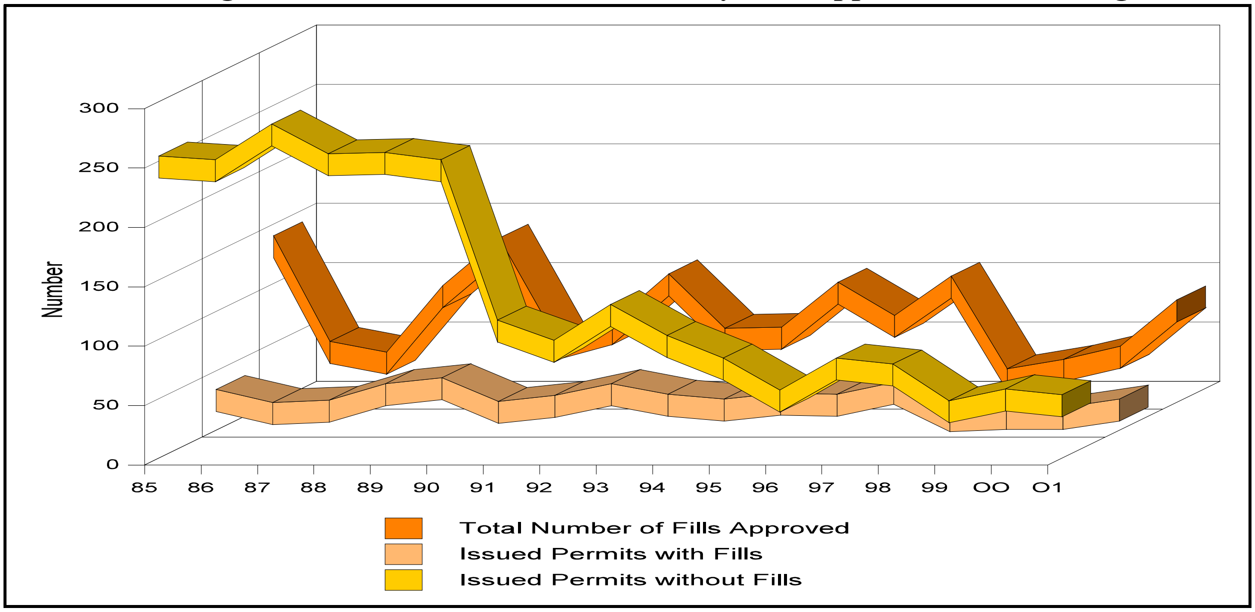
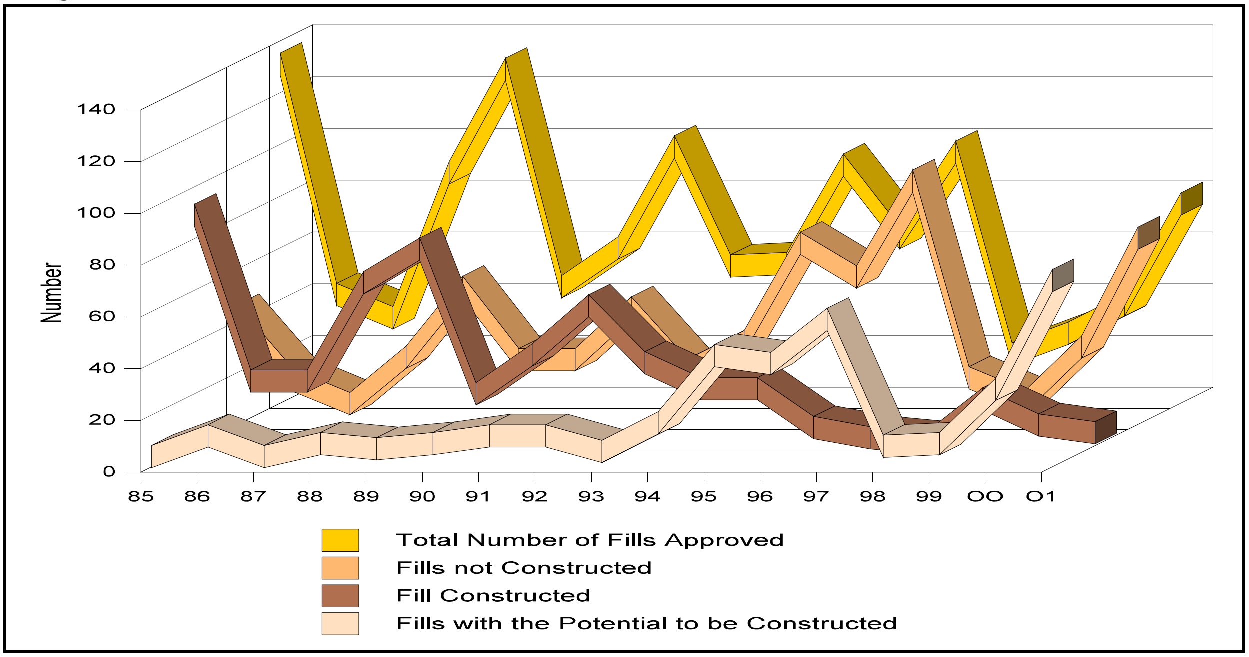


Figure III.K-21 shows trends in valley fills constructed or that having the potential to be constructed in West Virginia during the period from 1985 through 2001. A total of 856 (75 percent) of the 1147 of the approved valley fills are either constructed or may be constructed. The other 291 valley fills will not be built because the bonds have either been released or forfeited for those permits.

Figure III.K-21 Trends in Valley Fills Constructed or Proposed to be Constructed in West Virginia



3. Trends in Valley Fills Size

As with total excess spoil disposal, trends for individual valley fill sizes were developed for the Fill Inventory Study. For the EIS, available electronic databases were reviewed for the four states to provide an assessment of trends in valley fill size over time. These are similarly representative of valley fills that were proposed in permit applications, some of which may not have been or will not be constructed. The following summarizes the findings for the four states and the region.

a. Regional Valley Fill Size Trends

Figure III.K-22 is the total acreage of valley fills approved in each of the states contained in the study area for the period from 1985 through 2001. A total of 83,797 acres of land is covered by 6697 valley fills approved during the period.

Figure III.K-22 Trends in Valley Fill Acreage in States and Region

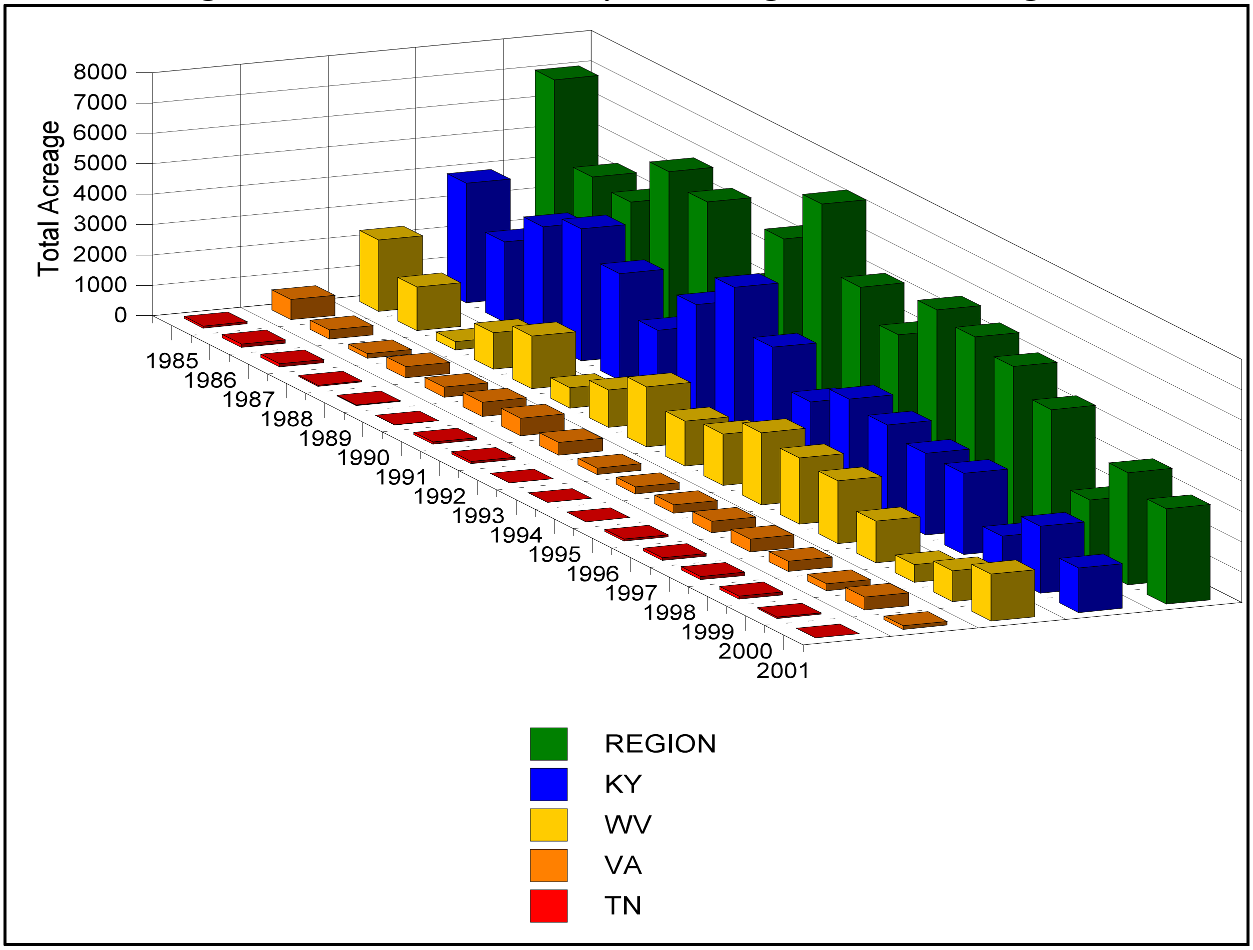


Table III.K-2 provides yearly data for total valley fill footprints approved, valley fill average sizes, and the range of valley fill sizes for the states within the study area.

Table III.K-2

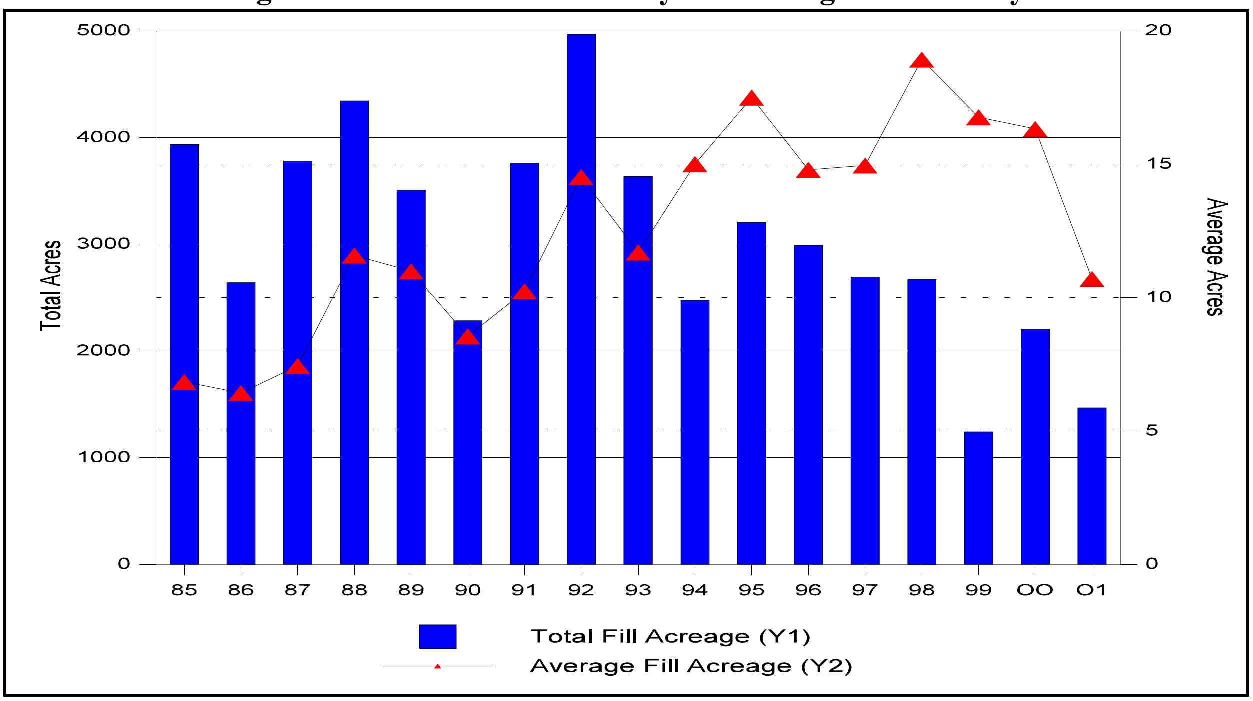
Year	Valley Fill Footprint Approved in Acres				Valley Fill Footprint Average Size in Acres				Range of Valley Fill Footprint Size in Acres			
	KY	TN	VA	WVA	KY	TN	VA	WVA	KY	TN	VA	WVA
1985	3,935	69	666	2,342	6.84	34.50	37.00	17.88	0.2-107	31-38	0.3-367	0.5-130
1986	2,640	115	306	1,437	6.42	28.75	10.56	34.24	0.2-77	2-81	0.5-55	0.3-272
1987	3,778	99	154	276	7.44	12.38	5.91	8.36	0.1-86	1-51	0.6-33	1.5-31
1988	4,342	34	367	1,205	11.58	5.67	10.80	13.54	0.5-188	1-26	0.6-147	0.6-68
1989	3,506	21	325	1,735	10.99	21.00	12.03	13.45	0.5-117	21	0.5-126	0.3-88
1990	2,282	3	473	673	8.55	3.00	13.15	14.98	0.4-62	3	0.2-160	0.7-58
1991	3,759	76	582	1,229	10.24	15.20	10.77	21.20	0.5-121	1-33	0.4-101	0.3-167
1992	4,966	73	419	1,974	14.52	14.60	14.97	19.95	0.5-174	2-59	0.6-99	0.6-153
1993	3,635	0	216	1,482	11.69	0	9.46	27.96	0.6-94	0	0.7-33	1.2-161
1994	2,475	0	235	1,692	15.00	0	7.58	31.30	0.6-99	0	0.6-69	0.5-256
1995	3,202	0	283	2,372	17.50	0	10.48	25.79	1.0-645	0	0.6-36	1.1-203
1996	2,988	69	374	2,179	14.79	69.0	16.24	38.05	0.2-134	69	0.3-56	0.2-216
1997	2,691	93	425	2,062	14.95	46.50	13.70	21.26	0.4-129	3-90	0.1-52	0.6-96
1998	2,668	109	333	1,379	18.92	15.57	9.78	72.60	0.5-173	2-65	0.8-55	1.2-473
1999	1,240	104	226	580	16.76	9.45	13.27	21.5	1.4-114	4-21	2.1-71	0.9-80
2000	2,203	44	425	1015	16.32	22.0	12.51	26.22	0.4-91		0.2-47	1.8-27
2001	1,465	0	126	1546	10.7	0	18.03	20.07	.14-92	0	8-30	0.8-99
Total	**51775**	**909**	**5935**	**25178**	**10.36**	**16.52**	**11.79**	**22.02**	**0.1-645**	**1-90**	**0.1-367**	**0.2-473**

b. Kentucky Valley Fill Size Trends

Figure III.K-23 shows that for the period from 1985 through 2001, the total approved valley fill acreage has generally decreased from a high of 4,966 acres in 1992 to a low of 1,240 acres in 1999. Although the total acreage of valley fills permitted increased again in 2000 to 2,203 acres, it decreased again in 2001 to 1,465 acres. The figure also shows that the average approved valley fill size has generally increased during the period, from a low of 6.42 acres in 1986 to a high of 18.92 acres in 1998.

Total valley fill acreage approved for the period is 51,775 acres. The average total valley fill acreage approved per year is 3,045 acres. The average approved valley fill size for the period is 10.36 acres. Individual approved valley fill acreage ranged from 0.1 acres in 1987 to 645 acres in 1995.

Figure III.K-23 Trends in Valley Fill Acreage in Kentucky

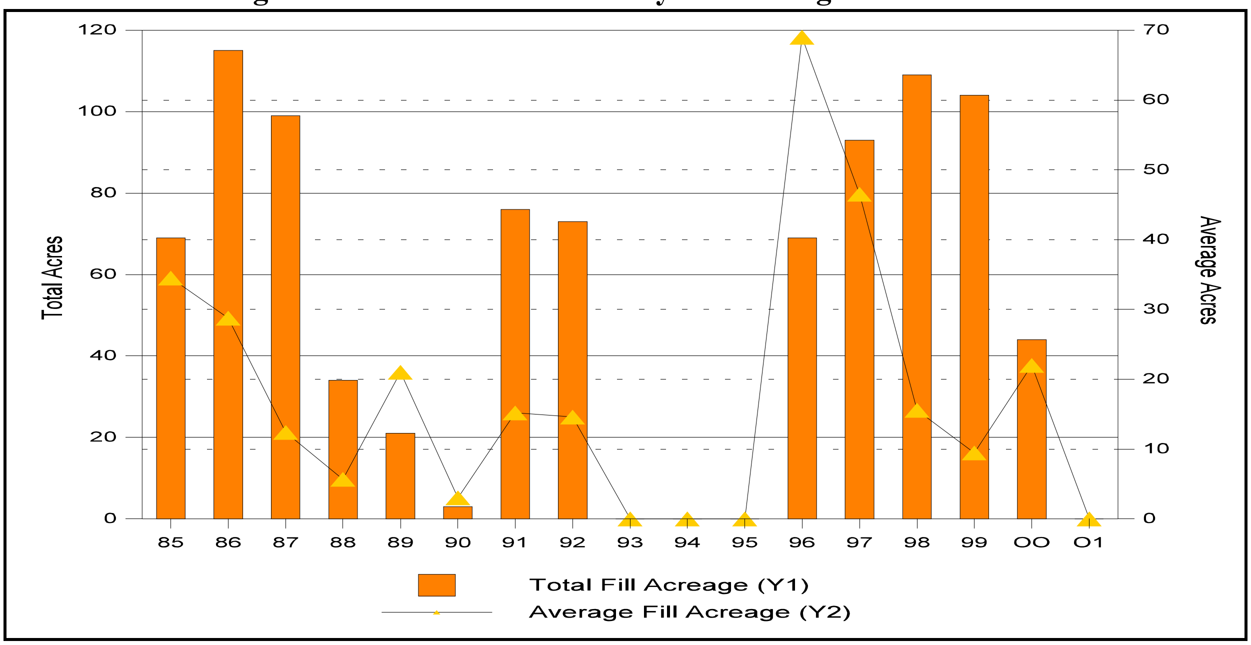


c. Tennessee Valley Fill Size Trends

As noted in Section III.K.2.c, Tennessee had a relatively small number of permits issued with valley fills. These limited data do not lend themselves well to a trend analysis, but Figure III.K-24 has been prepared for comparison to the other states. The high for total acreage approved was 115 acres in 1986. In some years, there were no permits issued with fills. The figure shows that the average approved valley fill size shows great variability, with a high of 69 acres in 1996, to a low of 3 acres in 1990.

Total valley fill acreage approved for the period is 909 acres. The average acreage approved per year is 52.88 acres. The average approved valley fill size for the period is 16.34 acres. Individual approved valley fill acreage ranged from 1 acre in a number of years to 90 acres in 1997.

Figure III.K-24 Trends in Valley Fill Acreage in Tennessee

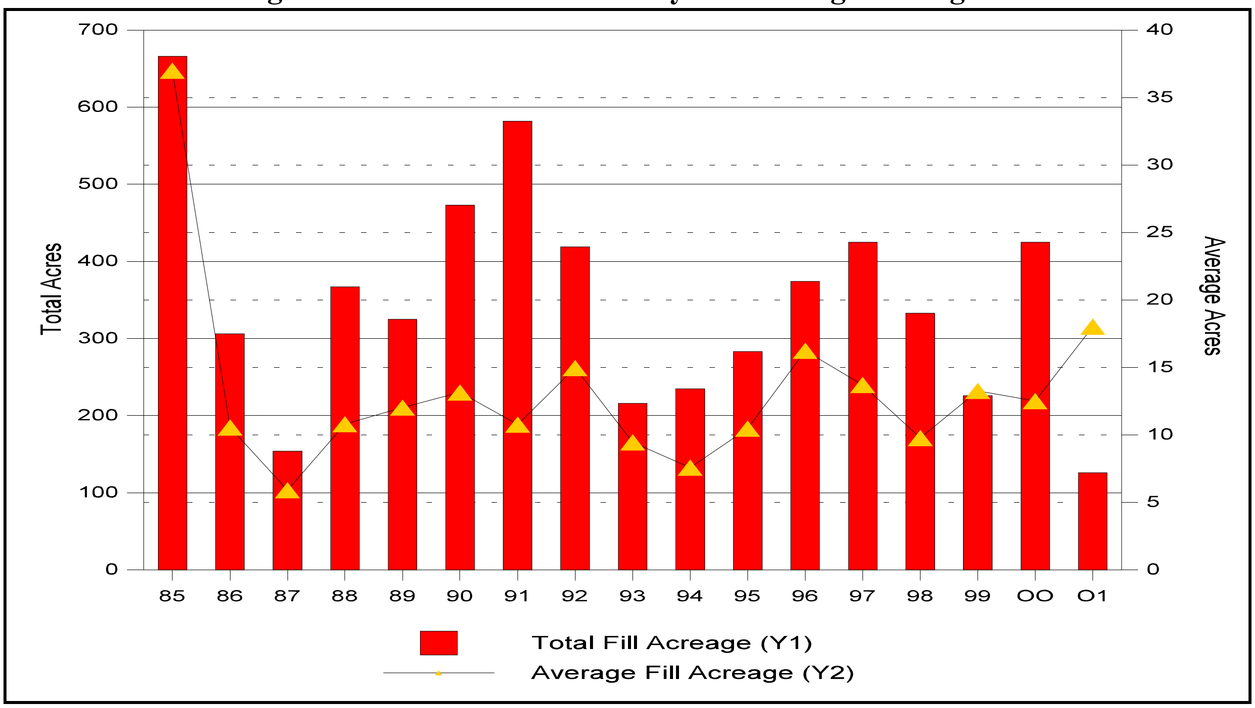


d. Virginia Valley Fill Size Trends

Figure III.K-25 shows great variability during the period from 1985 through 2001. Since 1990, the total approved valley fill acreage has generally declined with a few exceptions. In 1985, the approved total valley fill acreage was 666 acres and in 2001 it was 126 acres. The figure also shows that the average approved valley fill size varied from a high of 37 acres in 1985 to a low of 5.91 acres in 1987. Since 1990, the average approved valley fill size varied from a high of 16.24 acres in 1996 to a low of 7.58 acres in 1994.

The total valley fill acreage approved for the period is 5,935 acres. The average approved per year is 349 acres. The average approved valley fill size for the period is 11.79 acres. Individual approved valley fill acreage ranged from 0.1 acres in 1997 to 367 acres in 1985.

Figure III.K-25 Trends in Valley Fill Acreage in Virginia

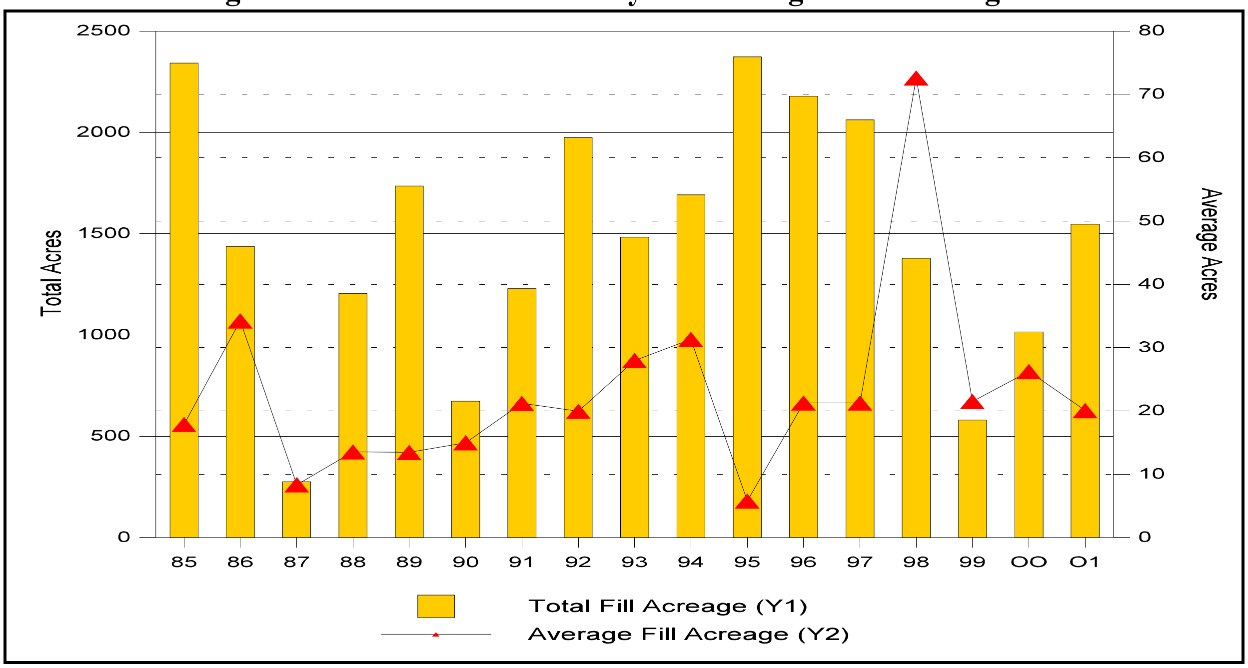


e. West Virginia Fill Size Trends

Figure III.K-26 shows a lot of variability during the period from1985 through 2001. The figure suggests that the total approved valley fill acreage has generally increased from a low of 276 acres in 1987 to a high of 2,372 acres in 1995. The figure also shows that the average approved valley fill size also has increased during the period with a high of 72.6 acres in 1998 to a low of 8.36 acres in 1987.

Total valley fill acreage approved for the period is 25,178 acres. The average acreage approved per year is 1,481 acres. The average approved valley fill size for the period is 22.02 acres. Individual approved valley fill acreage ranged from 0.2 acres in 1996 to 472.66 acres in 1998.

Figure III.K-26 Trends in Valley Fill Acreage in West Virginia



4. Trends in Watershed Size

As previously described, trends can be measured by the number of valley fills and their size. Another important aspect in evaluating valley fills and their impact on the environment is the impact to watersheds. This trend is very useful in evaluating and predicting overall impacts on the environment. The following provides a summary of trends in watershed sizes in each of the states within the study area.

a. Regional Watershed Trends

Valley fills are typically in headwater streams with varying sizes of watershed or drainage area above, or upstream, of the competed fill. Some valley fills may envelope the majority of the watershed, and others are farther downstream. The watershed acreage is determined by measuring the upland area above each fill toe. Figure III.K-27 is the total watershed acreage in which there are valley fills approved in each of the states contained in the study area for the period from 1985 through 2001. A total of 438,472 acres of watersheds are located above approved valley fills.

Figure III.K-27 Trends in Watershed Acreage in States and Region

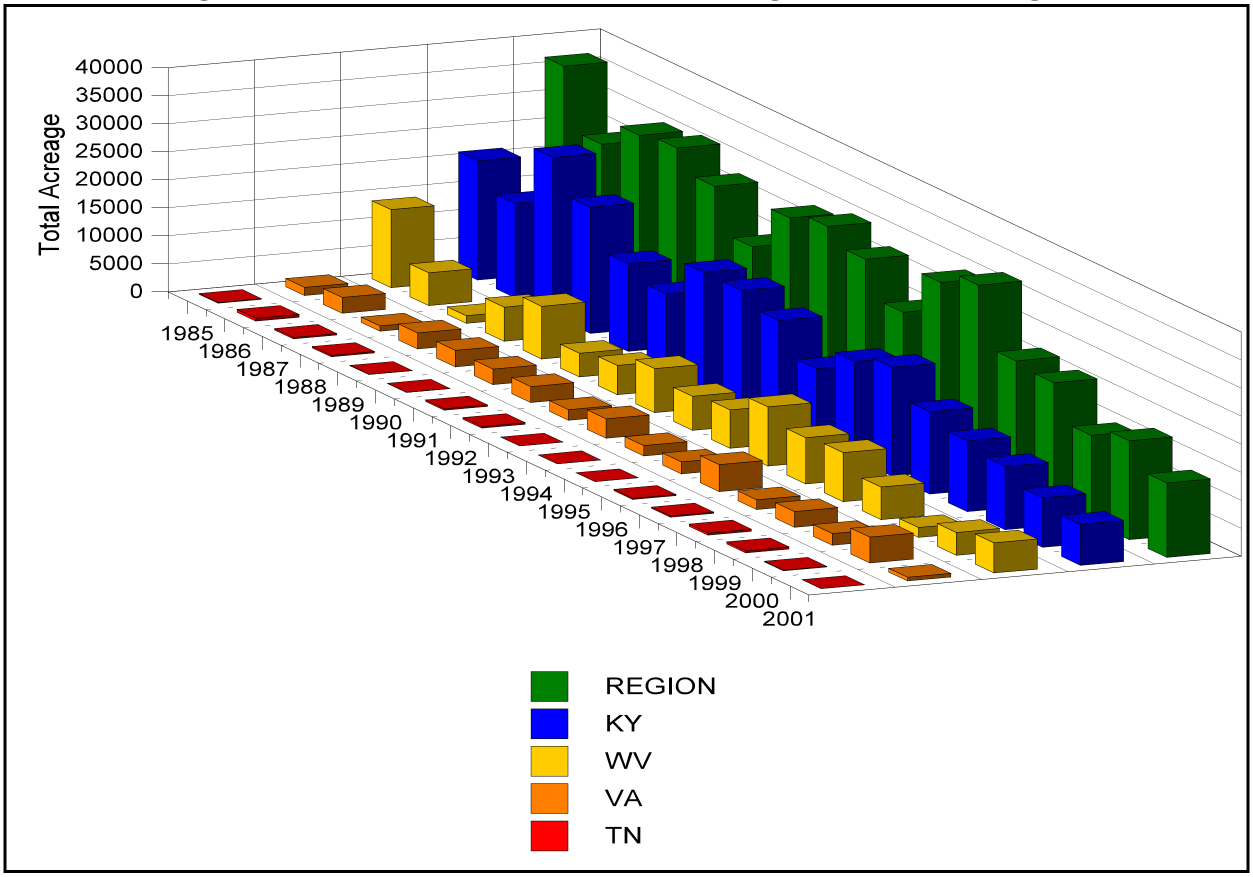


Table III.K-3 provides yearly data for watershed sizes for the states within the study area.

Table III.K-3
Watershed Impacts by States

Year	Total Watershed Impacted by Valley Fill Construction in Acres				Average Watershed Impacts by Valley Fill Construction in Acres			
	KY	TN	VA	WVA	KY	TN	VA	WVA
1985	21,262	150	1,430	13,938	36.8	75	79.5	106.40
1986	16,846	490	2,828	5,843	40.0	122.50	97.5	139.12
1987	28,234	269	915	1,379	55.0	33.63	33.9	41.79
1988	22,525	239	2,873	6,079	59.9	39.83	84.5	68.31
1989	15,646	45	2,944	9,429	48.6	45	109.0	73.09
1990	13,417	39	2,793	4,213	51.00	39	77.6	93.64
1991	20,464	255	2,823	5,228	55.3	51	50.4	90.14
1992	20,425	270	1,904	7,858	59.0	54	132.9	79.38
1993	18,237	0	3,454	6,085	58.1	0	132.9	114.82
1994	12,838	0	1,851	6,817	66.5	0	52.9	126.24
1995	17,305	0	2,112	10,575	74.3	0	78.2	114.95
1996	19,417	186	4,837	8,255	73.8	186	96.8	128.98
1997	14,662	234	1,741	8,773	73.3	117	54.4	90.45
1998	12,651	378	2,804	5,809	74.4	54	85.0	305.79
1999	11,259	364	2,071	1,744	71.7	33.09	79.7	64.60
2000	8,858	98	4,617	4,067	66.6	22	131.9	107.04
2001	7,301	0	632	5,387	50.7	0	90.3	70.88
Total	**281,347**	**3,017**	**42,629**	**111,479**	**51.78**	**54.85**	**78.41**	**97.28**

b. Kentucky Watershed Trends

Figure III.K-28 shows variability during the period from 1985 through 2001. Since 1990, the total watershed area impacted by valley fill construction has generally declined with a number of exceptions. In 1990, the total watershed area impacted by valley fill construction was 13,417 acres, and in 2001, it was 7,301 acres. The figure also shows that the average watershed acreage increased during the same period from a low of 51.00 acres in 1990 to 71.7 acres in 1999.

The total watershed acreage above valley fills constructed during the period is 281,355 acres. The average watershed size is 56.3 acres. Individual watershed acreage ranged from 0.8 acres in 1999 to 3,777 acres in 1987.

Figure III.K-28 Trends in Watershed Acreage in Kentucky

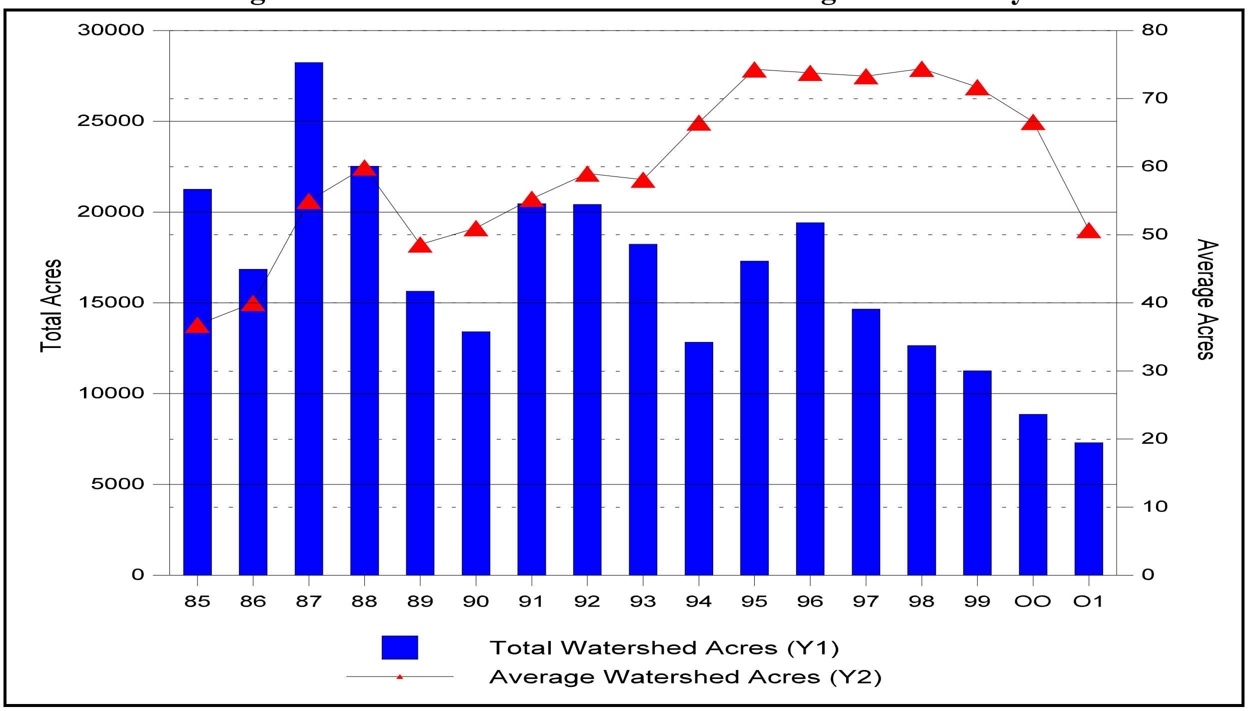


Table III.K-4 shows the distribution of watershed acres of valley fills approved in Kentucky for the period from 1985 through 2001. Eighty percent of the valley fills approved have watersheds less than 75 acres. As the table shows, 108 valley fills have a watershed greater than 250 acres in Kentucky.

Table III.K-4
Distribution of Watershed Sizes for Valley Fills in Kentucky

Watershed Acres	Year																	Total
	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	
Less than 75 Acres	519	378	432	289	275	216	308	262	253	138	165	193	136	116	104	972	121	4,002
75 Acres to less than 250 Acres	52	38	72	73	42	41	55	76	55	49	64	63	56	47	47	34	22	886
250 Acres and Greater	7	5	5	14	5	6	7	8	6	6	4	7	8	7	6	2	1	108

c. Tennessee Watershed Trends

As noted in Section III.K.2.c., Tennessee had a relatively small number of permits issued with valley fills. These limited data do not lend themselves well to a trend analysis, but Figure III.K-29 has been prepared for comparison to the other states. The high for total watershed acres with fills was 490 acres in 1986. In some years, there were no permits issued with fills. The figure shows variable average watershed acreage, with a high of 186 acres in 1996, and a low of 33.63 acres in 1987.

The total watershed acreage above valley fills constructed during the period is 3,017 acres. The average watershed size is 54.85 acres. Individual watershed acreage ranged from 2 acres in 1988 to 288 acres in 1998.

Figure III.K-29 Trends in Watershed Acreage in Tennessee

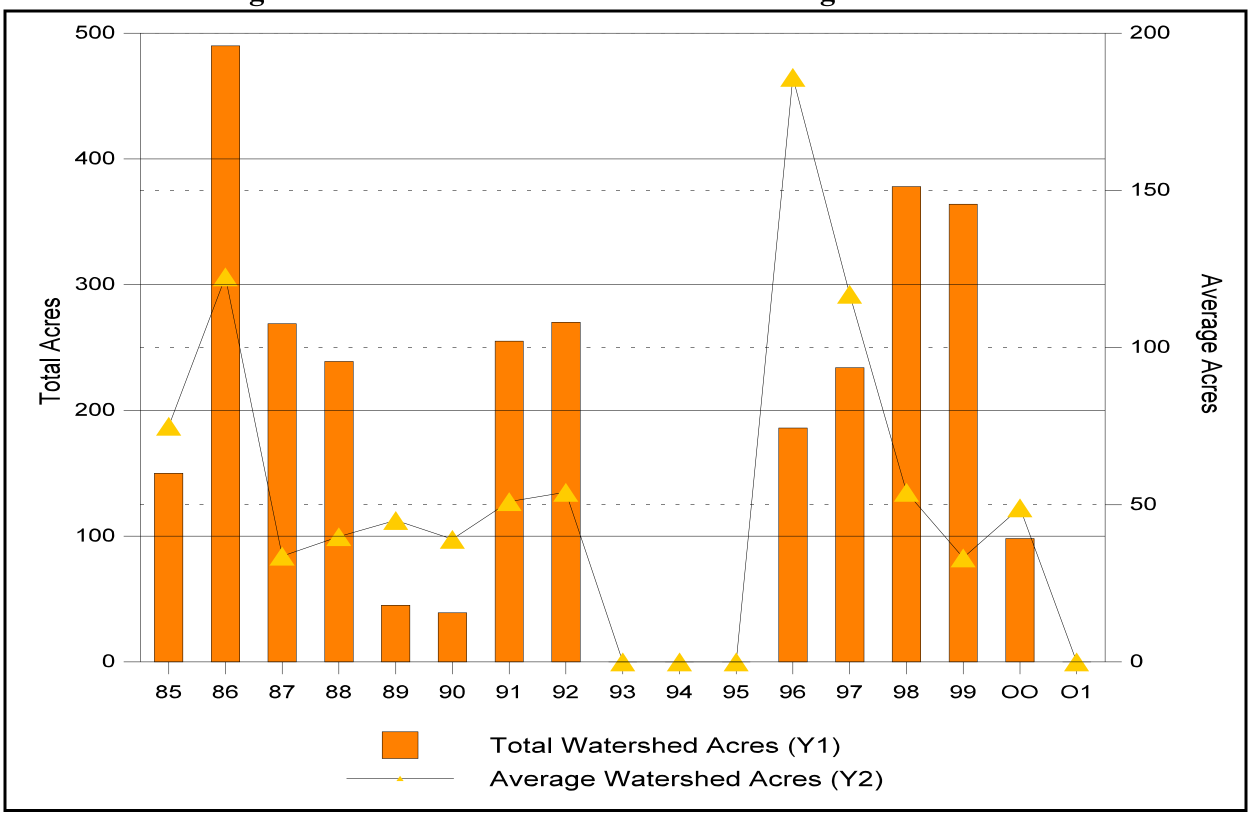


Table III.K-5 shows the distribution of watershed acres for valley fills approved in Tennessee for the period from 1985 through 1999. Seventy-nine percent of the valley fills approved have watersheds less than 75 acres. As the table shows, only one valley fill has a watershed greater than 250 acres in Tennessee.

Table III.K-5
Distribution of Watershed Sizes for Valley Fills in Tennessee

Watershed Acres	Year																	Total
	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	
Less than 75 Acres	1	2	8	4	1	1	4	4	0	0	0	0	1	6	10	2	0	44
75 Acres to less than 250 Acres	1	2	0	2	0	0	1	1	0	0	0	1	1	0	1	0	0	10
250 Acres and Greater	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1

d. Virginia Watershed Trends

Figure III.K-30 shows variability during the period from 1985 through 2001. Since 1990, the total watershed acreage has been irregular but does show an a slight trend toward smaller totals despite two notable exceptions in 1996 and 2000. In 1996, the total watershed area impacted by valley fill construction was 4,837 acres, and in 2001, it was 632 acres. Between 1990 and 2001, the average acreage of impacted watersheds was 2,636 acres per year. The figure also shows that the average watershed acreage varied from a high of 132.9 acres in 1993 to a low of 50.4 acres in 1991.

The total watershed acreage above valley fills constructed during the period is 40,526 acres. The average watershed size is 81.05 acres. Individual watershed acreage ranged from 1.5 acres in 1987 to 1,238 acres in 1989.

Figure III.K-30 Trends in Watershed Acreage in Virginia

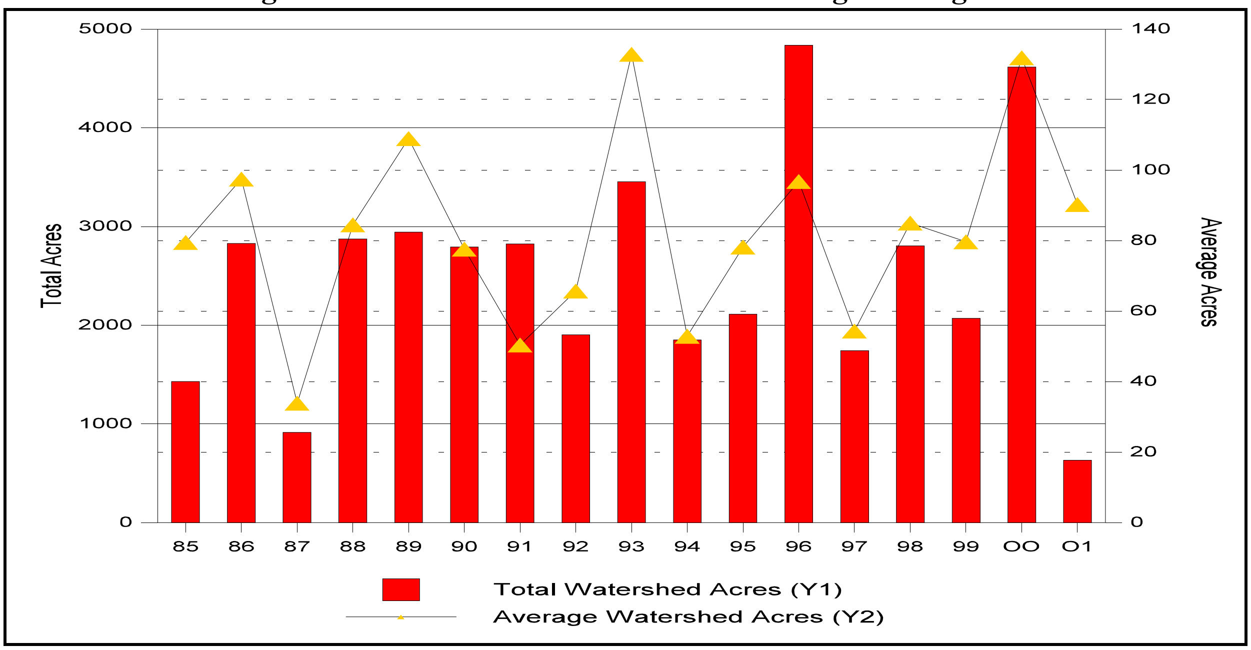


Table III.K-6 shows the distribution of watershed acres for valley fills approved in Virginia for the period from 1985 through 2001. Sixty eight percent of the valley fills approved have watersheds less than 75 acres. As the table shows, only 22 valley fills have a watershed greater than 250 acres.

Table III.K-6
Distribution of Watershed Sizes for Valley Fills in Virginia

Watershed Acres	Year																	Total
	85	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	
Less than 75 Acres	13	21	25	25	19	27	45	20	14	30	16	10	25	18	17	17	2	344
75 Acres to less than 250 Acres	4	6	2	8	6	8	9	8	7	4	11	12	7	15	8	14	5	134
250 Acres and Greater	1	2	0	1	2	1	2	1	5	1	0	1	0	0	1	4	0	22

e. West Virginia Watershed Trends

Figure III.K-31 shows variability during the period from 1985 through 2001. Between 1990 and 1997, the total watershed acreage impacted each year has generally increased. In 1998 and 1999 this acreage decreased significantly from a total of 8,773 acres in 1997 to only 1744 acres in 1999. In the last two years, there again appears to be an increase in the watershed sizes. The total watershed area impacted by valley fill construction has ranged from a high of 13,938 acres in 1985 to a low of 1,744 acres in 1999. The figure also shows that the average watershed acreage has gradually increased since 1987 from a low in 1987 of 41.79 acres to a high of 305.79 in 1998.

The total watershed acreage above valley fills constructed during the period is 111,479 acres. The average watershed size is 97.28 acres. Individual watershed acreage ranged from 0.2 acres in 1996 to 1,628 acres in 1985.

Figure III.K-31 Trends in Watershed Acreage in West Virginia

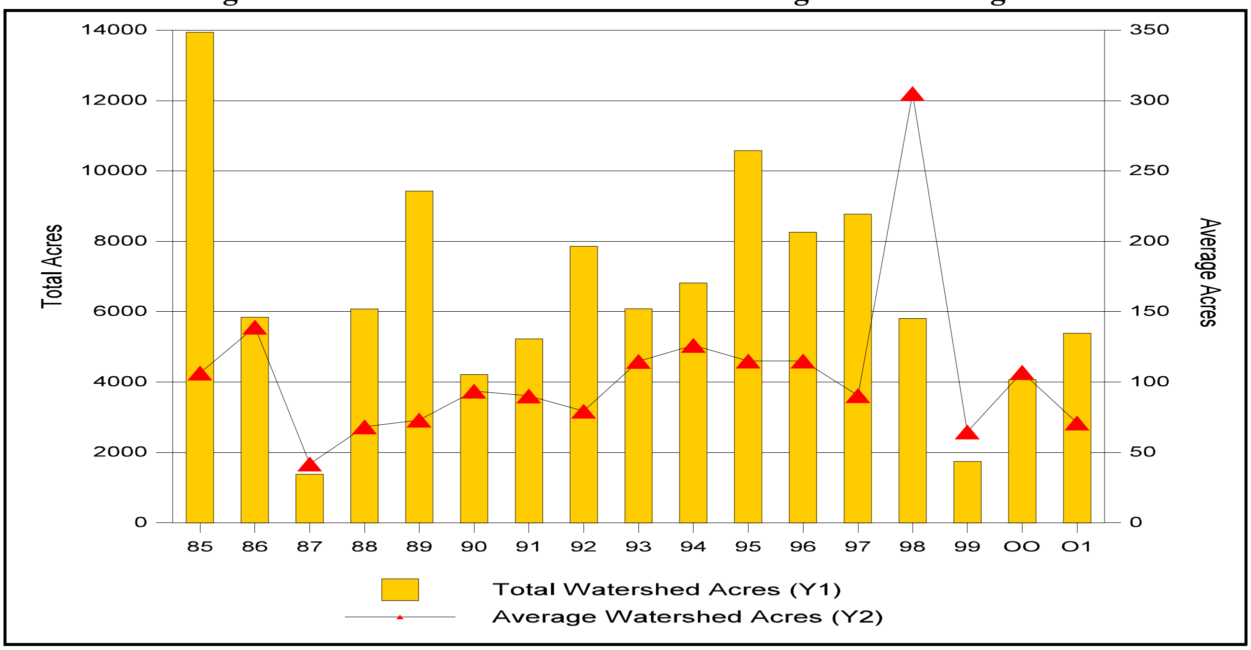


Table III.K-7 shows the distribution of watershed acres for valley fills approved in West Virginia for the period from 1985 through 2001. Fifty-nine percent of the valley fills approved have watersheds less than 75 acres. As the table shows, 73 valley fills have a watershed greater than 250 acres in West Virginia.

Table III.K-7
Distribution of Watershed Sizes for Valley Fills in West Virginia

Watershed Acres	Year																	Total
	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	
Less than 75 Acres	76	24	30	65	91	27	33	69	25	28	47	26	51	4	19	15	51	681
75 Acres to less than 250 Acres	44	14	3	22	33	15	20	25	24	20	35	32	42	8	7	23	26	393
250 Acres and Greater	11	4	0	2	5	3	5	5	4	6	10	6	4	7	1	0	0	73

5. Trends on Stream Impact Under Fill Footprints

The final measurement for evaluating impacts from valley fill construction and predicting their overall impact on the environment is stream loss. As discussed in III.K.2., the stream impact is based on a synthetic stream network defined on a 30-acre watershed accumulation threshold over the National Elevation Dataset (NED). The NED for each state was processed to enforce hydrologic integrity (filling of spurious sinks). A flow accumulation grid was prepared and queried to define a drainage network over the entire region. The stream network represents all drainage for watersheds greater than 30 acres. Table III.K.-8 provides a summary of trends on stream impacts by individual states within the study area.

Figure III.K-32 is the total length of stream impacts under the valley fill footprints approved in each of the states contained in the study area for the period from 1985 through 2001. The total of stream impact for states within the study area is 724 miles, or 1.23 percent of the 58,998 miles of streams within the study area.

Figure III.K-32 Trends in 30-Acre Synthetic Stream Impacts in States and Region

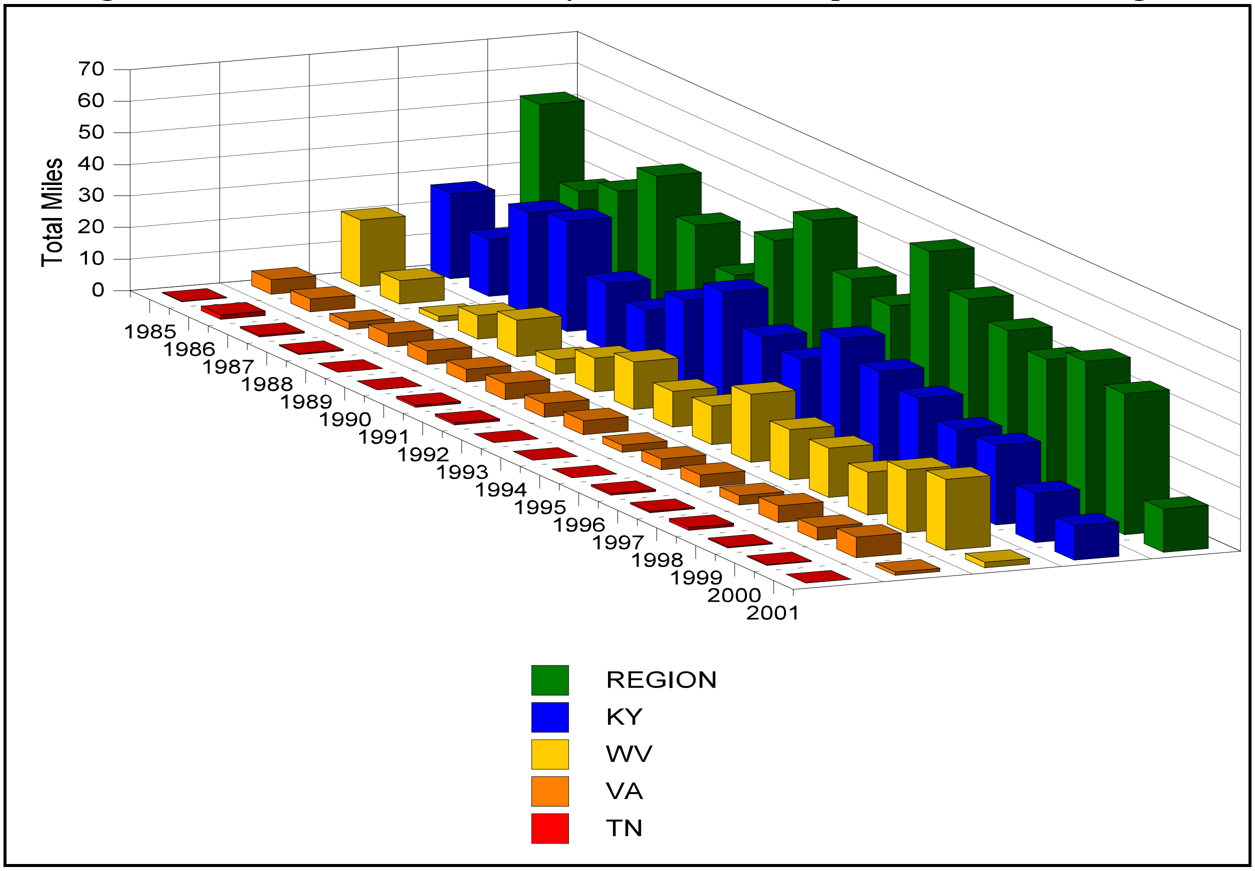


Table III.K-8
Yearly Totals by States for Impacts to Streams Under Valley Fill Footprints

Yr.	Stream Miles Under Valley Fill Footprints			
	KY	**TN**	**VA**	**WVA**
85	26.98	.22	4.6	21.02
86	18	1.42	4.04	7.39
87	32.07	.51	2.22	1.66
88	34.96	.33	4.27	7.55
89	20.81	0	4.32	11.66
90	17.85	.02	4.05	4.66
91	26.6	.65	5.16	10.73
92	34.9	.68	4.31	15.12
93	26.3	0	4.5	11.31
94	24.59	0	2.33	12.25
95	36.83	0	3.46	21.58
96	31.94	.58	4.01	15.91
97	28.99	.43	3	15.58
98	24.6	.92	5.36	13.55
99	25.19	.31	4.06	19.9
00	15.56	.24	6.58	22.41
01	10.19	0	1.09	1.73
Total	**436.36**	**6.31**	**67.36**	**214.01**

6. Relationship of Excess Spoil Generation to Mining Method

The gross volume of spoil generation on a given mine site is directly related to the total area of mining volume of overburden that is mined, and to the rock type of the overburden. Mining a given volume of sandstone would generate a larger volume of spoil than the same volume of shale regardless of mining method. Conceptually, mountaintop removal operations would generate the greatest volume of spoil on a given mine site, since that type of operation would remove all the overburden above the basal coal seam, typically at an overburden to coal or stripping ratio of approximately 15:1 (cubic yards overburden: ton of coal) in West Virginia. Total volume of excess spoil is related to the ability of the mine method and mine plan to return spoil to the bench. While mountaintop removal would normally be expected to generate the greatest volume of excess spoil on a given mine site, this is not always the case. An extensive (i.e., many linear feet or miles of contour cut) contour operation could generate more excess spoil (typical stripping ratio of 12:1 in southern WV) than a mountaintop removal operation on the same site because of bench spoil return restrictions imposed by maintaining sedimentation controls and haul roads along the croplines. The relationship of mining method to excess spoil disposal is therefore expected to be very site specific based on topography, overburden type, and extent of individual mining methods.

7. Relationship of Excess Spoil Generation to AOC Variance

To evaluate the possibility of a relationship between excess spoil generation and AOC variance status, several recent OSM Oversight Reports pertaining to AOC policies in the individual states were reviewed. In general, no definite relationship can be drawn from this information, largely due to differing policies regarding the need for AOC variances between the states and the lack of states achieving true AOC. However, it can be concluded that AOC variances would, inherently and by necessity, generally result in greater excess spoil volume in order to achieve a greater amount of flat land suited for alternative post-mining land uses. The following summarizes the findings for excess spoil disposal and AOC variance for each state.

a. Excess Spoil Generation and AOC Relationships in Kentucky

According to the 1999 OSM Oversight Report: "An Evaluation of Approximate Original Contour and Post-Mining Landuse in Kentucky," AOC variances were required to be requested by permit applicants if more than 20 percent of the original bank volume of the mine site's spoil was excess (i.e., to be placed in a fill). Under this policy, it would seem that permits with AOC variances would always have more excess spoil disposal than those that did not. However, Kentucky also required AOC variances for mine sites proposing to leave a permanent road, bench, terrace, or other feature exceeding 20 feet in width. Such circumstances could happen on any mine site whether fills were proposed or not, potentially skewing the results when included with sites that had variances for no reason other than excess spoil disposal. For this reason, no reliable relationship can be made between excess spoil disposal and AOC variance status in Kentucky.

b. Excess Spoil Generation and AOC Relationships in Tennessee

The limited number of permits that have been issued for excess spoil valley fills in Tennessee since 1988 (eight) allows a direct evaluation of the relationship for that state. Only one of the eight permits is reported to have had an AOC variance, and this permit proposed an excess spoil disposal of 24 percent. The remaining seven permits without AOC variance showed a proposed excess spoil disposal averaging 18 percent and ranging from 3 percent to 53 percent. Although the excess spoil disposal for the single variance permit was slightly higher than the average of the non-variance permits, it was still well within the range of the non-variance permits. This amount of data is too small for a definitive assessment of whether excess spoil disposal quantities are related to AOC variance in Tennessee.

c. Excess Spoil Generation and AOC Relationships in Virginia

The 1999 OSM Oversight Report "An evaluation of approximate original contour variances and post-mining land uses in Virginia" did not draw definite conclusions regarding a relationship between AOC variance and excess spoil generation. However, the report did state the following based on a sampling of Virginia mine permits: "Seventy percent of the permits in our sample proposed to place less material in fills than the predicted "swell" generated during mining. Due to the high percentage of remining sites in Virginia (80 percent of our sample), permittees' maintain most (83 percent) of the overburden generated during mining on the mine bench or on previously mined lands included within the permitted area. Because of the large amount of overburden retained on the mine benches and the overall configuration (including an average elevation change of -31' for AOC sites and -26' for variance sites) of the resulting land, one must question whether the majority of the sites in our study required a variance from approximate original contour restoration in the first place." From this it is inferred that most Virginia mines did not vary greatly in spoil disposal characteristics and reclamation practices between those with AOC variances and those without. Additional review of permit statistics would be required to verify that this is the case.

d. Excess Spoil Generation and AOC Relationships in West Virginia

The 1998 OSM Oversight Report: "Draft Report: An Evaluation of Approximate Original Contour and Post-mining Land Use in West Virginia"stated the following findings based on a sampling of West Virginia mine permit applications: "Where data was available, sites with AOC variances had a somewhat wider percentage range of excess spoil being placed in fills than did sites without AOC variances...the percentage of spoil being placed in fills ranged from 8 to 62 percent for sites with AOC variances and between 33 and 45 percent for sites without AOC variances. Both sites with and without AOC variances placed more material in the fill than could be accounted for by just the swell factor, which ranged from 20 to 40 percent, according to the permits...Current regulations do not place a numerical limit on the amount or percentage of material which may be placed in a fill..." An independent review of the OSM report data for this EIS did show the AOC variance sites to have a higher percentage of excess spoil disposal than those without variances, 45 percent compared to 40 percent. It is cautioned that this is a very limited sampling from which to draw any conclusions regarding a relationship between excess spoil disposal and AOC variance in West Virginia.

L. MINE FEASIBILITY EVALUATION AND PLANNING

The presence of coal reserves on a given site does not necessarily imply that the site can be economically mined. Evaluation of mining feasibility on any site requires a detailed investigation into the nature of the coal reserves and the physical, environmental, and regulatory constraints of the site. If a coal reserve is found to be conceptually feasible for mining, a mine plan must be developed to determine the actual economics and practical extent of the potential operation. Finally, the mine plan and attendant engineering and environmental controls must undergo regulatory scrutiny during the mine permitting process. This section provides an overview of the factors influencing mine feasibility and planning, and outlines the typical steps and considerations in developing a mine plan once a site has been determined to be feasible for mining. Figure III.L-1 provides a flowchart diagram of this overall process.

RETURN ON INVESTMENT AND PROFIT MAY NOT BE REALIZED UNTIL WELL INTO THE LIFE OF A MINE OR EVEN AFTER MINING IS COMPLETE WHEN RESIDUAL RECLAMATION BONDS HAVE BEEN RELEASED. THE DECISION TO PROCEED WITH A MINE SITE REPRESENTS A LONG-TERM COMMITMENT OF CAPITAL AND RESOURCES FOR A COAL COMPANY.

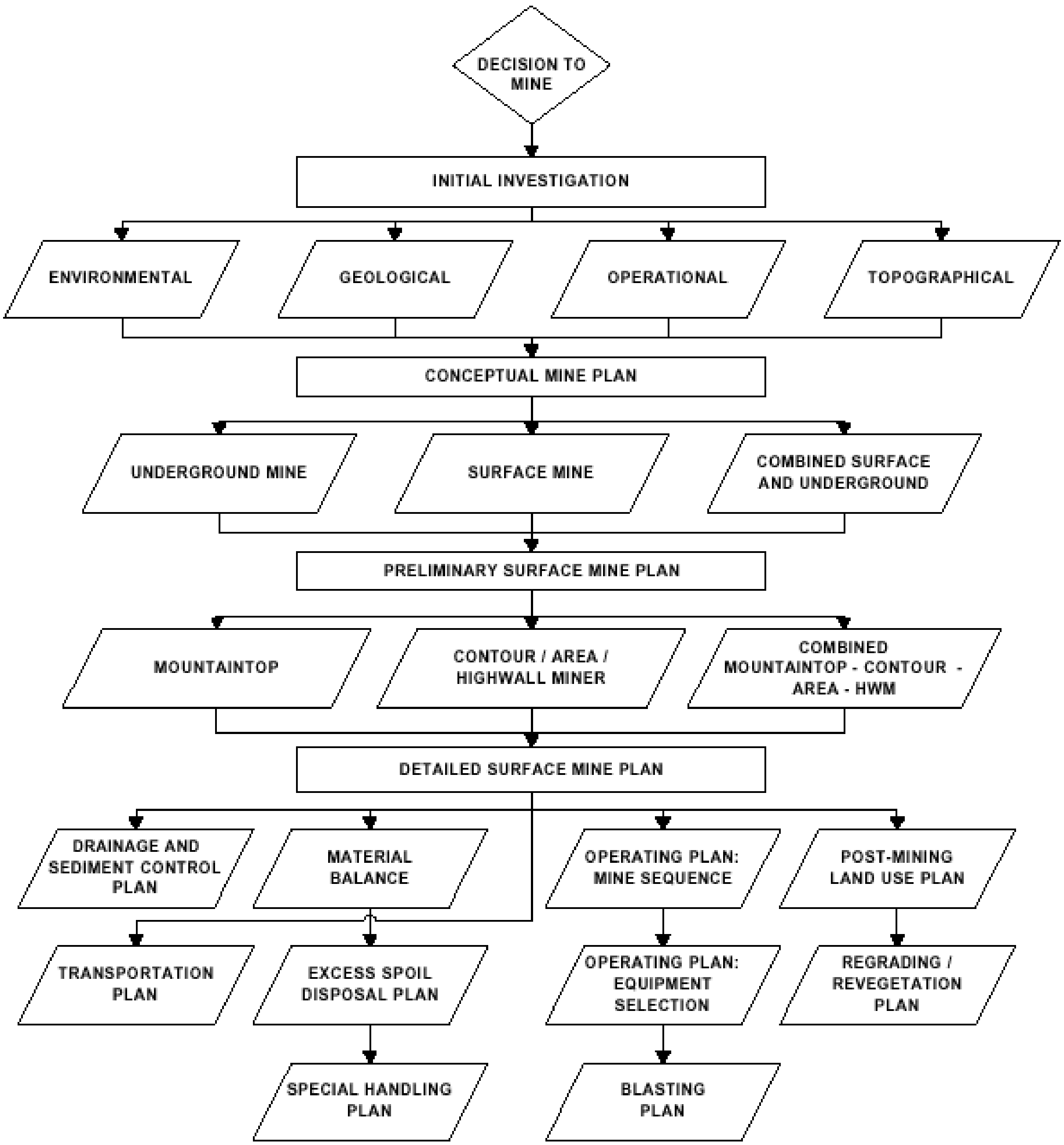
1. General Considerations

There are a number of economic and management factors that must be considered by a coal company before a decision is made to proceed with mine planning on a potential site. Mining in general requires a relatively high initial investment, with potential long-term delays in returns during the site planning, permitting, and development stages, and considerable risk due to fluctuations in market prices and production costs. Return on investment and profit may not be realized until well into the life of a mine or even after mining is complete, when residual reclamation bonds have been released and the mine site liquidated for other uses. The decision to proceed with a mine site, therefore, represents a long-term commitment of capital and resources for a coal company.

a. Property Ownership

To mine coal on a given piece of land, a coal company may already own the land, purchase the land outright, or lease the land from the landowner for mining purposes. Often, the mineral rights to the coal are owned separately from the surface property rights, and the coal company must negotiate with both parties for the right to mine. If a coal company does not own a property and/or attendant mineral rights, the typical arrangement is to pay the owners of these rights a royalty fee that can be based on the value or tonnage of coal mined. Royalty fees are established during the negotiation process for the mining rights. Other forms of mineral rights, such as oil and gas, may also conflict/compete with mining plans and need to be negotiated for protection or purchase. If a coal company owns or purchases a property for mining, it must consider the value that this land will represent after mining in determining the net cost of coal production. Coal mined from both owned

Figure III.L-1
Overall Mine Development Decision Process



Source: Miekle & Kitt, 1999

and leased land is also subject to a state (and sometimes local) severance tax--on top of royalties and production costs.

b. Capital Investment

Basic capital costs of mining include site development, equipment purchases, and on-site facilities. The costs to develop a site, such as haul road construction and utilities, may be partially offset by timber harvesting or recovered by postmining use of the land for residential, commercial, or industrial purposes. Some coal companies may lease mining equipment to avoid up-front capital expenditures, but most own their equipment. Large capital expenditure items, such as electric shovels and draglines, must normally be purchased outright. In general, investment in larger equipment reduces the cost per ton of production, but at the same time requires larger coal reserves and greater production rates (commensurate with the life of equipment) to justify the expenditure. Large mining operations may also invest in on-site coal processing plants and permanent structures for equipment maintenance and administration. These specialized facilities may be partially salvaged for use on other sites, but are otherwise not readily transferable for other postmining land uses.

c. Reclamation Bonding

Activation of a mine permit requires that reclamation bonds be posted on areas to be mined. The purpose of these bonds is to provide assurance that the coal operator will reclaim the mine site according to the approved reclamation plan, or to provide funds for the government to complete this work should a coal operator forfeit its responsibilities. SMCRA (30CFR 800.15) does not specify dollar amounts for bonding rates, other than requiring that no bond for a single permit be less than \$10,000. Bond amounts, however, are based on a "worst-case" scenario based on the maximum amount of disturbed area open at any one time and may range from a few hundred thousand to many millions of dollars. The individual state regulatory authorities are responsible for establishing bonding rates that reflect the probable difficulty of reclamation, giving consideration to such factors as topography, geology, hydrology, structure and facility removal, and revegetation potential. The amount of the bond is intended to be sufficient to assure the completion of the reclamation plan if the work had to be performed by the regulatory authority in the event of forfeiture. Reclamation bonds are released in phases, with Phase 1 release occurring after backfilling and regrading have been completed on a given area, Phase 2 occurring after completion of revegetation activities, and the final Phase 3 release occurring after the mine site has been accepted as being satisfactorily reclaimed and the approved post-mining land use met (i.e., meets all performance standards and the approved permit plan). Complete release of reclamation bonds on a given area typically requires five years after completion of reclamation, and may be delayed further if satisfactory reclamation has not been achieved. Additional time may be required for attainment of certain post-mining land uses, such as commercial forest land. A coal company will usually post reclamation bonds through a bonding company, paying a percentage of the total bond as a fee, rather than making this outlay by itself. Larger companies post other types of sureties and collateral bonds with company assets at stake.

Virginia and West Virginia surface mining regulatory programs utilize approved alternative bonding systems.

In Virginia the reclamation bonding requirement may also be met by participation in the Virginia Coal Surface Mining Reclamation Fund (Pool Bond Fund). Participation in the Pool Bond Fund is optional for permittees. In order to qualify for participation in the Pool Bond Fund, a permittee must demonstrate to the VADMLR's satisfaction that they have at least a consecutive three-year history of compliance under the Act or any other comparable State or Federal Act. Participation in the Pool Bond Fund shall constitute an irrevocable commitment by the permittee to participate in regards to the applicable permit and for the duration of the coal surface mining operations covered by the permit.

An applicant filing a permit application which proposes to be pool bonded must pay an entrance fee prior to the issuance of the permit. The entrance fee is $5,000 when the total balance of the Fund is less than $1,750,000 and is $1,000 when the total Fund balance is greater than $2 million. A renewal fee of $1,000 is required of all permittees in the Fund at permit renewal.

Participants in the Virginia Pool Bond Fund must also post bond as follows:

(1) For those underground mining operations participating in the Fund prior to July 1, 1991, in the amount of $1,000 per acre covered by the permit. In no event shall the total bond be less than $40,000, except that on permits which have completed all mining and for which completion reports have been approved prior to July 1, 1991, the total bond shall not be less than $10,000.

(2) For underground mining operations entering the Fund on or after July 1, 1991, and for additional acreage bonded on or after July 1, 1991, the amount of $3,000 per acre. In no event shall the total bond for such underground operations entering the Fund on or after July 1, 1991, be less than $40,000.

(3) For all other coal surface mining operations participating in the Fund prior to July 1, 1991, the amount of $1,500 per acre covered by each permit. In no event shall such total bond be less than $100,000, except that on permits which have completed all mining and for which completion reports have been approved prior to July 1, 1991, the total bond shall not be less than $25,000.

(4) For other coal mining operations entering the Fund on or after July 1, 1991, and for additional acreage bonded on or after July 1, 1991, the amount of $3,000 per acre. In no event shall the total bond for such operations entering the Fund on or after July 1, 1991, be less than $100,000.

If a pool bond permit is placed into temporary cessation for more than six months, participants must post bond equal to the total estimated cost of reclamation for all portions of the permitted site which are in temporary cessation. The additional bond must remain in effect throughout the remainder of the period during which the site is in temporary cessation. At such time as the site returns to active status, the additional bond posted may be released.

Participants in the Pool Bond Fund must pay taxes according to the following schedule. At the end of any calendar quarter where the total balance of the Pool Bond Fund, including interest thereon, is less than $1,750,000, all permittees participating in the Pool Bond Fund shall pay within 30 days after the end of each taxable calendar quarter, an amount equal to the following.

(1) Four cents per clean ton of coal produced by the surface mining operation of the permit during the taxable calendar quarter.

(2) Three cents per clean ton of coal produced by the underground mining operation of the permit during the taxable calendar quarter.

(3) One and one-half cents per clean ton of coal processed or loaded by the preparation or loading facility operation of the permit during the taxable calendar quarter.

At the end of any calendar quarter where the total balance of the Pool Bond Fund, including interest thereon, exceeds $2 million, payments shall be deferred until the balance is less than $1,750,000 at the end of a quarter. No permittee is required to pay the reclamation tax on more than five million tons of coal produced per calendar year, regardless of the number of permits held by that permittee, except upon permit issuance the permittee must pay the applicable reclamation tax required on coal mined and removed under the permit during the one year period commencing with and running from the date of the commencement of coal production, processing or loading from that permit.

Permittees participating in the Pool Bond Fund and holding more than one type of permit are not required to pay a reclamation tax at a rate in excess of five and one-half cents per ton on coal originally surface mined by that permittee or in excess of four and one-half cents per ton on coal originally deep mined by that permittee. Permittees holding one permit upon which coal is both mined and processed or loaded are not required to pay more than the tax applicable to the surface mining operation or underground mining operation. However, the permittee must pay the one and one-half cents per clean ton for all coal processed and/or loaded at the permit which originated from other permits during the calendar quarter.

In West Virginia, the alternative bonding system requires a bond for each operation at the rate of $1,000 per acre (or fraction of an acre), with a minimum bond of $10,000. In order to supplement the amount of the bond provided by individual operators, the state established a special reclamation fund provided by taxes levied on the amount of coal produced by each operator. The amount of money in the fund can fluctuate between approximately one to two million dollars. The tax of one cent per ton is levied on each active mining operation. Monies contained in the fund are used for reclamation of areas where the bonds provided by individual operators are not sufficient to cover the actual costs of reclamation.

d. Coal Market Conditions

The market valuation of coal reserves is a critical factor in mine feasibility. The coal quality of reserves on a given property is also a significant determinant in a mine's ability to meet market needs. Many mines must recover particular seams of particular quality (often including blending of seams) to meet exacting contract specifications for coal with certain properties (e.g. heat value, as expressed in BTUs, or British Thermal Units, sulfur content, ash value, moisture content, etc.) for a specific use (i.e., steam coal for electrical generation, coking coal for steel making, etc.). Demand for coal and coal prices fluctuate due to a number of factors, including annual variations in weather patterns affecting heating and power generation, and costs of alternative fuels, such as petroleum. Coal companies will sometimes delay permitting of new mine sites or activation of existing permits if market conditions are not currently favorable for coal production. Production costs include labor, fuel and power, equipment maintenance, transportation, and administration and engineering services. All of these costs are variable, depending on current economic conditions. Active mines are vulnerable to fluctuations in market prices and production costs because they cannot be simply idled for long periods of time. Capital payments on large pieces of mining equipment demand that they remain productive, and environmental regulations require that mine disturbances be reclaimed in a timely manner.

e. Permitting Requirements

Aside from the multitude of design and performance constraints stipulated by regulation, the most significant influence that permitting requirements have on mine planning is the time delay required between initiation of the permitting process and approval to mine. This may take a year or longer from the time of application submission, depending on the size and complexity of a mine site, and the nature and extent of its potential impacts on environmental resources. Mine planners must account for this delay in obtaining new reserves, such that production lags do not occur while waiting for a new permit to be approved. Since it is possible for a mine permit application to be denied during regulatory review, it is prudent to have approved permits in place prior to their need for activation. Mine permit applications are typically prepared for a coal company by an independent consultant, but some larger companies utilize in-house environmental and mining engineering staff.

Over time, the Corps has increased mitigation requirements on Section 404 CWA permits. The Corps strives for no net loss of aquatic functions. The requirement to avoid, minimize and then compensate for unavoidable impacts to waters of the United States has become a larger economic factor in the mining decision. Mine planners should account for the costs of mitigation associated with 404 permits. The use of stream assessment methods, which assess stream quality, can play a significant role in siting mining disturbances to avoid or minimize stream impacts. The methodology should be used early in mine planning to decide if higher quality streams can be avoided because the mitigation costs can be substantially higher than mitigation costs associated with highly degraded streams. Also, the potential for permit denial or a more lengthy permitting time-frame can result when impacts to high value aquatic resources are at stake. The reliance on compensatory mitigation to insure impacts are minimal on an individual and cumulative basis, will likely result in a greater need for financial assurances or bonding to guarantee mitigation is completed.

2. Site-Specific Considerations

Once a potential mine site has been identified and the general considerations for mining are found to be favorable, mine planners will begin to investigate the site in detail to determine whether mining is conceptually feasible. These background investigations provide the information necessary for most later planning stages. Figure III.L-1 summarizes the various avenues of investigation under four basic categories, as discussed in the following sections.

a. Geological

Of primary importance to mine planners are the numbers, extents, thicknesses, and qualities of coal seams present on a site. The process of determining these factors is called a *reserve evaluation*. Preliminary investigations can be conducted remotely using geological surveys and other records from previous mine operations. If the site warrants further investigation, an exploratory drilling program is implemented to measure actual coal depths and thicknesses, record overburden types and properties, and secure samples for laboratory analysis. This information is not only necessary for a company to evaluate the economic feasibility of bringing a product to market or fulfill contract requirements, but is also required by SMCRA for permitting. The coal, overburden, surface and groundwater, and other features and properties must be sampled and analyzed at enough points throughout the proposed permit area to be representative of baseline conditions-and to allow prediction of mining impacts. Coal is analyzed for its quality factors, including sulfur, ash, moisture, and heat content, while overburden is analyzed for environmental and strength factors, including sulfur content, neutralization potential, geotechnical parameters, chemical and textural suitability as topsoil substitute, and slake durability. In general, the lower the ash and moisture content, and higher the heat content or BTU value, the higher the market value of the coal. Core samples are also recovered from coal seams to identify quality and quantity (thickness) changes and partings that may be present within individual seams and require special operational consideration.

A second important consideration during the reserve evaluation is the extent of previous mining. Aside from residual environmental consequences, such as acid mine drainage, former mine workings can render remaining coal reserves on a site uneconomical for recovery. Surface mining of former underground mines may be of marginal viability, as only a fraction of the original coal remains in place, as is the case with areas of previous highwall or auger mining. Former contour cuts from old surface operations may have also left remaining coal reserves under too great an overburden cover to be extracted by new surface methods. Alternately, the reclamation of abandoned previous mining may have a positive influence on the mine permitting process. Elimination of abandoned highwalls, daylighting of underground mines adversely impacting water quality, and extinguishing mine fires can all be viewed as environmental benefits of new operations on previously mined sites.

b. Topographical - Geographical

Topography and geography relate to the land forms of the mine site and its relationship to other environmental and cultural features in the vicinity. Most large mine sites now employ aerial photogrammetric mapping to develop accurate contour maps of potential mine sites. Results from reserve evaluation activities are then added to the site mapping to produce a three-dimensional database of site conditions. Areas surrounding the mine site are usually depicted using USGS topographic quadrangle maps-mechanically reproduced at a larger scale, typically 1 inch = 400 hundred feet. Geographic, environmental, demographic, and cultural features can then be added to the site map and spatially evaluated for their potential influence on mine planning. SMCRA requires that maps of this nature be submitted with permit applications. Maps, or cross-sections and profiles developed from these maps, must show such things as pre-mining slopes, geologic structure, surface and groundwater information, coal outcrops, access roads, diversions, mining cut sequences, location of toxic- and acid-forming overburden, well locations, nearby residents--just to name a few.

Primary topographic constraints within a mine site are slopes, degree of coal seam exposure, and availability of access, sediment control and excess spoil disposal sites. Geographic constraints include distance to public roads, coal processing facilities, coal shipping points, and electric utility service. Demographic factors include proximity to occupied buildings, property lines, workforce availability, municipal regulations, and taxes. Cultural resources, such as historical structures, cemeteries, Native American artifacts, and other sites of unique heritage may be present within a mine site and require special protection. Proximity to parks and other protected public lands also comes into consideration when evaluating the potential difficulties in permitting a given site.

c. Operational

Operational considerations relate to the mining methods and support requirements that may be practical for a prospective site. Foremost for steep-slope surface mining is the availability of excess spoil disposal areas in a practical geometry. Access routes for haul roads of an acceptable grade must also be present. Existing underground mines and gas wells may have to be avoided, particularly in the case of active operations.

Other important operational considerations are transportation distances for coal haulage and support materials. Transportation of coal is a significant percentage of its total production cost, and mine sites must be located within a reasonable distance of high-volume shipping points, such as railroads or barge loading facilities. Both large- and small-scale mining operations require access to petroleum fuel for equipment, although this is now largely satisfied by overland truck haulage and on-site storage. Large-scale mines may also require access to high-voltage electrical service to operate draglines, electric shovels, and other equipment. Running new high-voltage service to remote sites can represent a considerable expense, and such sites may be relegated to petroleum-fueled operations only.

3. MTM/VF Mine Economic Analysis

To provide a conceptual understanding of the economic factors associated with MTM/VF mine operations, this section summarizes an economic analysis for a typical large MTM/VF mine operation. This example is based on a case study of an actual mine operation in West Virginia, as presented by Meikle & Fincham (1999), and is an approximation of the typical MTM/VF mine characteristics outlined in the previous section. Operational statistics for the example mine site are presented in Table III.L-1. The following summarizes the mine site economics in terms of capital investment, employment, costs and earnings, taxes, and a comparison to the underground mining alternative. The ultimate return on investment for this mine was 9.6%.

a. Capital Investment

Capital investments are related to physical investment in a mine site and do not include the costs of day-to-day mine operation and maintenance. These investments are usually categorized for surface mine operations by heavy equipment, support equipment, and development costs. Individual investments required for the example mine under these categories are summarized in Tables III.L-2, III.L-3, and III.L-4, respectively. As these tables show, the majority of capital investment (about 70 percent) occurs during the first year of mine operation as the site is developed and equipment is purchased. Later capital investments are generally related to replacement of equipment over time. The total capital investment for the project is $58,345,000.

Table III.L-1
Example MTM/VF Mine Operational Statistics

Mine Statistic	Value	Units
Projected Mine Life	10	years
Total Coal Production	16,395,984	CT
Annual Coal Production	1,680,000	CT
Average Selling Price of Coal	$24.75	
Coal Tons per Man Hour	7.25	CT/MH
Mine Recovery Rate	80.36	%
Direct Shipping Percentage	80.00	%
Total Depth of Cut	436	feet
Number of Seams Mined	8	
Stripping Ratio	15.02	BCY/CT
Total Overburden Moved	246,283,400	BCY
Overburden Moved per Year	25,200,000	BCY
Total Overburden Haulage (70%)	172,398,380	BCY
Total Cast Blast and Dozing (30%)	73,885,020	BCY
Swell Factor	30	%
Total Spoil Generated	320,168,420	LCY
Spoil Returned to Mine Bench	192,101,051	LCY
Spoil Placed in Valley Fills	128,067,368	LCY
Spoil Return Percentage	60	%
Yards Overburden per Man Hour	108.90	BCY/MH
Total Man Hours Worked	2,261,507	MH

CT - clean tons BCY - bank cubic yards
MH - man hours LCY - loose cubic yards

Source: Meikle & Fincham, 1999

Table III.L-2
Example MTM/VF Mine Economic Analysis
Capital Budget - Life of Mine

HEAVY EQUIPMENT

Item Description	Year 0	Year 1	Years 2 thru 10	Total
25 Yard Shovel	$0	$3,500,000	$0	$3,500,000
18 ½ Yard Backhoe	$0	$2,650,000	$0	$2,650,000
16 Yard Endloader	$0	$1,200,000	$1,200,000	$2,400,000
210 Ton Rock Trucks	$0	$4,500,000	$0	$4,500,000
150 ton Rock Trucks	$0	$7,320,000	$0	$7,320,000
Fill Dozers	$0	$2,160,000	$1,050,000	$3,210,000
Development Dozers	$0	$1,440,000	$1,440,000	$2,880,000
Reclamation Dozers	$0	$720,000	$720,000	$1,440,000
45 Yard Dozers	$0	$4,800,000	$4,800,000	$9,600,000
16 Yard Coal Loader	$0	$2,400,000	$700,000	$3,100,000
9 Yard Coal Loader	$0	$1,100,000	$500,000	$1,600,000
Drills	$0	$2,400,000	$4,800,000	$7,200,000
Total	$0	$34,190,000	$15,210,000	$49,400,000

Source: Meikle & Fincham, 1999

Table III.L-3
Example MTM/VF Mine Economic Analysis
Capital Budget - Life of Mine

SUPPORT EQUIPMENT

Item Description	Year 0	Year 1	Years 2 thru 10	Total
Motor Grader	$0	$400,000	$0	$450,000
Water Truck	$0	$600,000	$0	$600,000
5 Yard Backhoe	$0	$300,000	$0	$300,000
Light Plants	$0	$150,000	$0	$150,000
Mechanics Trucks	$0	$520,000	$0	$520,000
Fuel Truck	$0	$130,000	$0	$130,000
Service Truck	$0	$260,000	$0	$260,000
Portal Trucks	$0	$75,000	$0	$75,000
Pick-Up Trucks	$0	$150,000	$300,000	$450,000
Total	$0	$2,635,000	$300,000	$2,935,000

Source: Meikle & Fincham, 1999

Table III.L-4
Example MTM/VF Mine Economic Analysis
Capital Budget - Life of Mine

CAPITAL DEVELOPMENT

Item Description	Year 0	Year 1	Years 2 thru 10	Total
Haul Road	$1,000,000	$0	$0	$1,000,000
Pond Construction	$500,000	$0	$1,000,000	$1,500,000
Stream Mitigation	$500,000	$0	$0	$500,000
Permitting Related	$500,000	$0	$0	$500,000
Exploration	$350,000	$0	$0	$350,000
Clearing & Grubbing	$460,000	$230,000	$920,000	$1,610,000
Office/Warehouse	$200,000	$0	$0	$200,000
Radio System	$50,000	$0	$0	$50,000
Pump System	$150,000	$0	$0	$150,000
Power & Phones	$150,000	$0	$0	$150,000
Total	$3,860,000	$230,000	$1,920,000	$6,010,000

Source: Meikle & Fincham, 1999

b. Employment

Table III.L-5 provides a detailed breakdown of the manpower allocation required for operation of the example MTM/VF mine site. The example site runs two 10-hour shifts per day, 5 days per week, for a total of 260 working days per year. A day shift with 47 employees and night shift with 42 employees combine for a total labor force of 89 employees working 231,400 man hours per year. Equipment operators are the majority of the labor force at 70 percent, with support technicians comprising about 20 percent, and supervisory staff making up the remaining 10 percent of the employees.

c. Costs and Earnings

The costs of mining coal at the example MTM/VF mine site are shown in relationship to the gross earnings for the sale of coal in Table III.L-6. Sale of coal at $24.75 per ton generates a gross revenue of $405,800,604. From this, the costs of marketing and transportation, overhead and reclamation, and production mining are subtracted, leaving a cash margin of $78,204,696. This equates to a production cost per ton of $19.98 and cash margin of $4.77 per ton. Deduction of capital depreciation and amortization leaves a net earning before interest and taxes of $26,513,450. Labor and supplies are the largest single cost category for coal production, about 60 percent of the total. Supplies and trucking costs together are about 44 percent of the total production cost. These two categories are largely dependent on fuel costs and are thus the most vulnerable to fluctuation over the life of the mine. The total direct wages and benefits earned by employees during the life of the mine are $83,796,596, and total service and supply expenditures for this period are $145,722,663.

Table III.L-7 provides a breakdown of the example mine's cash flow statistics over its operational life. Initial capital outlays and production costs result in a net operating loss of about $34,000,000 through the first year of mining. The return on this investment is not realized until the 8th year of mine operation. The rate of return on the investment is estimated at 9.60 percent.

d. Taxes

Coal mining is subject to a number of taxes on the federal, state, and sometimes local levels. For the example MTM/VF mine site, these add up to $58,073,684 over the life of the mine, equating to $3.54 per ton and representing 14 percent of its total market value. The coal severance tax is the largest component of the total tax burden at $1.24 per ton, or 35 percent of the total. Table III.L-8 lists the individual taxes to which the mine operation is subject by total mine life cost and cost per ton of coal.

Table III.L-5
Example MTM/VF Mine Economic Analysis
MANPOWER TABLE

Period: Full Year

Production Days = 260 days

C.T. Per M.H.		7.25
BCY Per M.H.		108.90

Manpower				Job Description	O.B. Production	# Prod. Days	Hrs. Per Day	Total Manhours
Position	Day	Evening	Total					
25 yd. Front Shovel	1	1	2	O.B. Loading	7,500,000	260	10	5,200
210 Ton Rock Truck	3	3	6	O.B. Haulage		260	10	15,600
Fill Dozer	1	1	2	Run Fill		260	10	5,200
18 ½ yd. Backhoe	1	1	2	O.B. Loading	5,800,000	260	10	5,200
150 Ton Rock Truck	3	3	6	O.B. Haulage		260	10	15,600
Fill Dozer	1	1	2	Run Fill		260	10	5,200
16 yd. Endloader	1	1	2	O.B. Loading	4,100.,000	260	10	5,200
150 Ton Rock Truck	2	2	4	O.B. Haulage		260	10	10,400
Fill Dozer	1	1	2	Run Fill		260	10	5,200
45 yd. Bull Dozer	4	4	8	Prod. Dozing	7,800,000	260	10	20,800
Development Dozer	2	2	4	Development		260	10	10,400
Reclamation Dozer	1	1	2	Reclamation		260	10	5,200
16 yd. Coal Loader	2	2	4	Coal Prep. Ldg.		260	10	10,400
9 yd. Coal Loader	2	2	4	Coal Prep. & Ldg.		260	10	10,400
Drillers	4	3	7	O.B. Drilling		260	10	18,200
Motor Grader	1	1	2	Road Maint.		260	10	5,200
Water Truck	1	1	2	Dust Control		260	10	5,200
Mechanics/Welders	2	6	8	Maintenance		260	10	20,800
P.M. Technicians	1	2	3	Maintenance		260	10	7,800
Fueler/Greaser	1	1	2	Maintenance		260	10	5,200
Blasters	6	0	6	Blasting		260	10	15,600
Blasting foreman	1	0	1	D & B Superv.		260	10	2,600
Prod. Foreman	1	1	2	Shift Superv.		260	10	5,200
Maint. Foreman	1	1	2	Maint. Superv.		260	10	5,200
Maint. Planner	1	1	2	Maint. Scheduling		260	10	5,200
Prod. Engineer	1	0	1	Engineering		260	10	2,600
Superintendant	1	0	1	General Superv.		260	10	2,600
Total	47	42	89		25,200,000			231,400

Source: Meikle & Fincham, 1999

Table III.L-6
Example MTM/VF Mine Economic Analysis of Earnings Before Interest and Taxes

	Total Project		
Parameter	$$	$$ Per BCY	$$ Per C.T.
Revenues	$405,800,604	$1.65	$24.75
Revenues Per ton	$24.75		
Non-Mining Costs:			
Sales Related Costs	$59,771,560	$0.24	$3.65
Intercompany Royalties	$0	$0.00	$0.00
Intercompany Commissions	$4,098,996	$0.02	$0.25
Trucking	$33,666,422	$0.14	$2.05
Other Transportation Costs	$9,837,593	$0.04	$0.60
Preparation Costs	$12,752,441	$0.05	$0.78
Subtotal	$120,127,012	$0.49	$7.33
Net Realization	$285,673,592	$1.16	$17.42
Indirect Costs:			
Overhead	$8,996,465	$0.04	$0.55
Reclamation	$2,459,394	$0.01	$0.15
Subtotal	$11,455,859	$0.05	$0.70
Mining Costs:			
Labor	$83,956,796	$0.34	$5.12
Supplies	$112,056,241	$0.45	$6.83
Subtotal	$196,013,037	$0.80	$11.95
Cash Margin	$78,204,696	$0.32	$4.77
Cash Margin Per Ton	$4.77		
Cash Cost Per Ton	$19.98		
Direct D.D. & A.	$51,691,246	$0.21	$3.15
Indirect D.D. & A.	$0	$0.00	$0.00
Subtotal	$51,691,246	$0.21	$3.15
Earnings Before Interest & Taxes (E.B.I.T.)	$26,513,450	$0.11	$1.62

Source: Meikle & Fincham, 1999

Table III.L-7
Example MTM/VF Mine Economic Analysis
CAPITAL INVESTMENT STATISTICS ($millions)

Parameter	Initial Inv. Year 0	Year #1	Year #2	Year #3	Year #4	Year #5	Year #6	Year #7	Year #8	Year #9	Year #10	Year #11
E.B.I.T.	$0.00	$2.43	$2.57	$2.64	$2.79	$2.82	$1.45	$1.55	$1.70	$5.22	$3.33	$0.00
Taxes @ 30%	$0.00	$0.73	$0.77	$0.79	$0.84	$0.85	$0.44	$0.47	$0.51	$1.57	$1.00	$0.00
Commissions	$0.00	$0.42	$0.42	$0.42	$0.42	$0.42	$0.42	$0.42	$0.42	$0.42	$0.32	$0.00
Taxes on Comm.	$0.00	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	$0.13	$0.10	$0.00
Intercompany Royalty	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Taxes on Intercompany	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Tax Savings Depl.	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Net Income	$0.00	$2.09	$2.14	$2.14	$2.25	$2.27	$1.31	$1.38	$1.49	$3.95	$2.56	$0.00
(Add) DD&P	$0.00	$5.29	$5.29	$5.29	$5.22	$5.23	$6.53	$6.53	$6.48	$2.97	$2.85	$0.00
(Less) CapEx	$3.86	$37.06	$0.48	$0.23	$0.48	$2.78	$10.66	$1.70	$0.00	$2.55	$0.00	($6.65)
Net Cash Flow	($3.86)	($29.77)	$6.90	$7.21	$6.99	$4.72	($2.82)	$6.21	$7.97	$4.37	$5.41	$6.65

N.P.V. @ 5%	$7.45
N.P.V. @ 8%	$2.26
N.P.V. @ 10%	($0.52)
I.R.R.	9.60%
Payback Period	7.56 yrs

Cash Flows 1 - 11	
E.B.I.T.	$26.51
Net Inc.	$21.43
Net Cash	$19.98

Source: Meikle & Fincham, 1999

Table III.L-8
Individual Taxes
By Total Mine Life Cost and Cost Per Ton of Coal

Taxes	Total Mine Life Cost	Cost Per Ton of Coal
Personal Property Tax	$3,132,574	$0.19 per ton
Worker's Compensation	$5,559,085	$0.34 per ton
Matching FICA	$3,097,378	$0.19 per ton
Unmined Mineral Tax	$1,173,000	$0.07 per ton
Franchise Tax	$504,390	$0.03 per ton
Severance Tax	$20,290,033	$1.24 per ton
Black Lung Tax	$8,747,264	$0.53 per ton
Federal Reclamation Tax	$5,566,431	$0.34 per ton
WV Special Assessment	$819,798	$0.05 per ton
Federal & State Income Tax	$9,183,734	$0.56 per ton
TOTAL	**$58,073,684**	**$3.54 per ton**

Individual taxes and tax rates vary between states in the study area. It is predicted that total taxes would be $4,189,994 less if this same operation where conducted in Kentucky, and $12,187,134 less if it were conducted in Virginia.

4. Mining Method Considerations

Selection of the appropriate mining method(s) for a given site is a complicated, iterative process during the mine feasibility evaluation and planning stages. Choices are typically driven by the desire to maximize coal recovery with the least expensive mining method that is practical for a given coal seam. This section summarizes the basic considerations for mine method selection.

a. Mine Method Selection Factors

The two basic options in mine method selection are surface and underground mining, or a combination of the two. For surface operations, contour, area, and mountaintop removal methods are available individually or in combination, and room and pillar and/or longwall mining are available for underground operations. The primary factors used for deciding between the individual methods are summarized in Table III.L-9.

Table III.L-9
Summary of Mine Method Selection Factors

Selection Factor	Surface Methods			Underground Methods	
	Contour	Area	Mountaintop Removal	Room & Pillar	Longwall
Coal Seam Thickness	≈ 1 ft	≈ 1 ft	≈ 1 ft	>= 28 in	>= 6 ft
Stripping Ratio	≈ 10 - 12	≈ 12 - 15	≈ 15 - 20	NA	NA
Maximum Cover	varies - 100	varies -	varies -	≈ 1,500 ft	> 1,500 ft
Minimum Cover	NA	NA	NA	100 ft	> 100 ft
Reserve Size	L - M	M - H	H	L - M	H
Recovery Rate	varies	< 100%	up to 100%	40 to 80 %	up to 85%
Excess Spoil Generation	L - M	M - H	M - H	NA	NA
Capital Investment	L	M - H	H	L - M	H
Equipment Size	L	M - H	H	L - M	H
Mine Plan Flexibility	M - H	L - M	L	M - H	L
Orphan Reserves	M	L	NA	M - H	L - M

Relative value for comparison: L - Low, M - Moderate, H - High, NA - Not Applicable
Source: Gannett Fleming, Inc.

When dividing a reserve between surface and underground mining methods, stripping ratios may be first applied to determine which seams are impractically deep for surface mining. Lower seams meeting the thickness and cover criteria for either of the two underground methods may then be considered for underground operations. The upper seams are examined more closely to refine their applicable surface mining methods. The maximum practical extent of contour mining may first be delineated for each seam by its stripping ratio. Remaining interior cores of ridges or mountaintops are then evaluated to determine how far mining can progress using stripping ratios generated by multiple-seam area or mountaintop removal approaches. Thus, more than one mining method may be applied on a given site.

Application extent for individual mining methods may be further constrained by site factors not related to stripping ratio alone, such as a reserve size being too small to justify heavy-equipment mining methods. Extent of mining can be limited by availability of excess spoil disposal volume, favoring contour mining over area or mountaintop removal methods. Site geometry of topography and coal seams may be incompatible with the capabilities of equipment spreads, leading operations to become “spoil bound,” or not having sufficient space to maneuver and place spoil. The equipment or capital investment capabilities of an operator may also dictate a lesser extent of mining than conceptually feasible. Mine plan flexibility becomes a consideration for marginal operations under unstable market conditions. A final important consideration is generation of orphan reserves, or those that will be left permanently unmineable due to high stripping ratios after completion of mining. Evaluation of feasibility of highwall mining to partially recover these reserves requires consideration of lengths of time that pits must remain open and their extent as this relates to backfilling of spoil from other working areas of the mine.

M. COAL DISTRIBUTION AND MARKETS

1. Coal Uses and Distribution

The Energy Information Administration (EIA) develops and publishes energy market projections. The projections are "business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations" (USDOE EIA, 2000). Selected EIA coal related projections from the *Annual Energy Outlook, 1999* (USDOE EIA, 2000) are presented in this sub section and the ones that follow.

Nationally, the predominant use of coal is for electricity generation. Coal use in electricity generation has grown and is projected to continue growing. The combined other uses of coal have fallen since at least 1970 and are projected to increase only very slightly. [Figure III.M-1 Electricity and Other Coal Consumption, 1970-2020]

Figure III.M-1

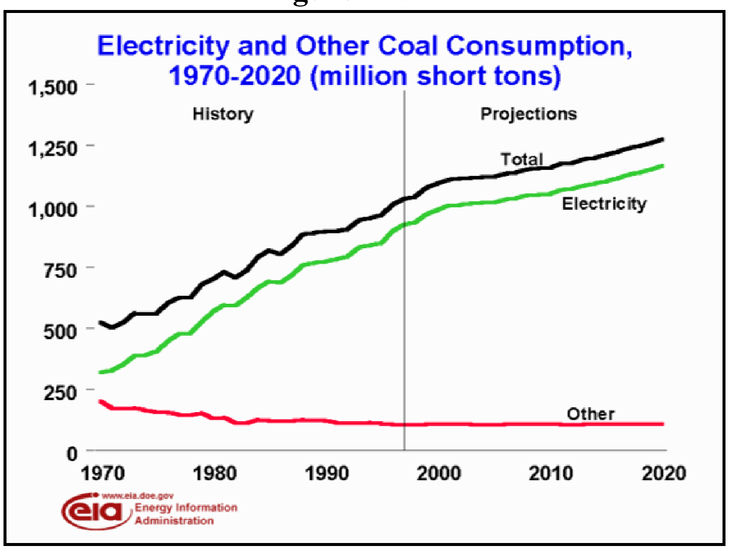


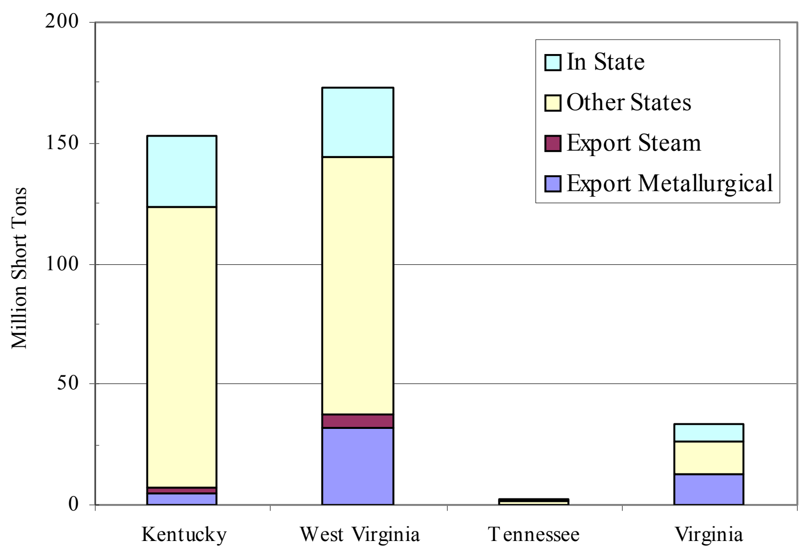
Table III.M-1 and Figure III.M-2 display the distribution of coal produced in the study area states in 1998. West Virginia is the leading exporter of U.S. coal. Its exports of 37.5 million short tons represent 47 percent of total foreign distributions in 1998. Twenty-two percent of West Virginia's 1998 coal production was exported. Metallurgical coal is the state's dominant export, comprising 86 percent of West Virginia's coal exports.

Table III.M-1
Coal Distribution, 1998
(million short tons)

Destination	Producing State				Percent of Total Production			
	KY	WV	TN	VA	KY	WV	TN	VA
Export Metallurgical	5.0	32.2	—	12.6	3%	19%	0%	37%
Export Steam	1.9	5.3	—	0.2	1%	3%	0%	.5%
Other States	116.5	106.6	1.3	13.1	78%	62%	48%	39%
In State	29.7	28.5	1.4	7.6	20%	17%	52%	23%

Source: U.S. Department of Energy, Energy Information Administration., 2000. *Coal Industry Annual, 1998.*

Figure III.M-2
Coal Distribution, 1998



Source: U.S. Department of Energy, Energy Information Administration, 2000. Coal Industry Annual, 1998.

While Virginia's output is much smaller than that of West Virginia, exports figure even more prominently in its coal distribution patterns. Nearly 38 percent of its 1998 production was exported; the great majority of this being metallurgical coal. Tennessee recorded no coal exports in 1998. Kentucky exported four percent of its 1998 production, about three-quarters of it as metallurgical coal. Kentucky's steam coal exports have fallen considerably from their five year high at 6,055 thousand short tons in 1995 to 1,889 thousand short tons in 1998. Kentucky metallurgical coal exports in 1998 are roughly unchanged from 1993 levels.

2. Productivity and Price Trends

One of the most noteworthy trends of the past decade of coal mining is the increase in labor productivity. Gains in coal mine labor productivity result from technology improvements, economies of scale, and better mine design. Improvements in labor productivity have been, and are expected to remain, the key to lower coal mining costs. Labor productivity, measured as short tons of coal, per miner, per hour, has improved as shown in Table III.M-2 below:

Table III.M-2
Coal Mining Productivity (short tons per miner per hour)

Region	1998		1989		Avg. Annual % Change	
	Under-ground	Surface Mines	Under-ground	Surface Mines	Under-ground	Surface Mines
Eastern Kentucky	3.28	4.27	2.40	2.92	3.5	4.3
So. West Virginia	3.89	5.74	2.57	3.71	4.7	5.0
Tennessee	2.25	2.90	1.58	2.20	4.0	3.1
Virginia	2.56	3.54	2.15	2.59	2.0	3.6
Wyoming	10.09	39.79	3.21	21.38	13.6	7.1

Source: U.S. Department of Energy, Energy Information Administration, 2000. Coal Industry Annual, 1998.

The table illustrates impressive gains in productivity in the study area and also illustrates Wyoming as an example of western coal productivity. The gains in Wyoming (the largest coal-producing state in the U.S.) and the vastly higher productivity in that state relative to the Appalachian coalfields are noteworthy because of increasing competitive pressure from western coal. Wyoming coal miners enjoy extraordinarily thick seams that lie close to the earth's surface. The higher labor productivity in surface mining compared to underground mining reflects the inherently greater labor intensity of underground mining.

On a national average, the share of wages in minemouth prices was 31 percent in 1970 and has fallen to 17 percent in 1998. The EIA projects that continued improvements in mine productivity (averaging 6.2 percent a year since 1977) will cause falling real mine prices throughout the forecast.

Figure III.M-3 Coal Mining Labor Productivity by Region 1990-2020 (short tons per miner per hour), displays the increasing labor productivity in the recent past and over the forecast period and contrasts the high productivity western coalfields with those of the eastern U.S.
Table III.M-3 illustrates the relative minemouth prices among regions and the fall in prices over the period 1989-1998. The table illustrates the higher price of underground mined coal versus surface mined coal. It also illustrates the considerably lower minemouth price of western coal (that pulls down the national average price) and the greater declines in western coal prices compared to that

of the study area. Figure III.M-4 Average Minemouth Price of Coal by Region, 1990-2020 (1997 dollars per ton), depicts the historic and projected trends for falling minemouth prices in both eastern and western coalfields. It should be noted here that coal consumers are considering other factors besides mine month price, including coal quality and transportation costs.

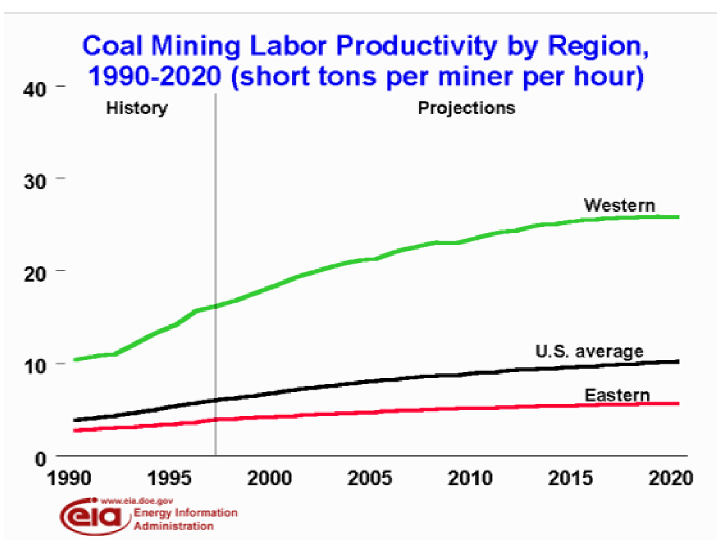
Table III.M-3
Average Mine Price ($ per short ton)

Region	Price in 1998			1989-1998
	Undergroun d	Surface	Average	Avg. Annual % Change
Eastern Kentucky	$25.36	$23.57	$24.59	-0.5
Southern West Virginia	$29.28	$24.79	$27.57	-0.6
Tennessee	w	w	$28.69	0.7
Virginia	$29.55	$26.21	$28.69	0.4
Western U.S.	$17.58	$7.77	$8.76	-3.5
United States	$25.64	$12.92	$17.67	-2.3

Source: U.S. Department of Energy, Energy Information Administration, 2000. *Coal Industry Annual, 1998.*

In addition to falling minemouth prices, coal transportation costs are projected to fall, resulting in lower utility prices for coal. Falling coal prices are projected to continue contributing to decreased costs at coal fired power plants. Since 1980, the per-kilowatt-hour fuel costs for coal fired power plants have fallen significantly. Fuel prices have been declining since the early 1980s. Generating costs for coal fired plants decreased by 49 percent from 1980 to 1996. In addition, non-fuel operations and maintenance costs are also expected to fall. Efforts to cut staff and reduce operating costs were prompted by the combination of technology improvements and competitive pressure. The amount by which utilities can continue to cut costs is uncertain, but many analysts agree that further reductions are possible (USDOE EIA, 2000).

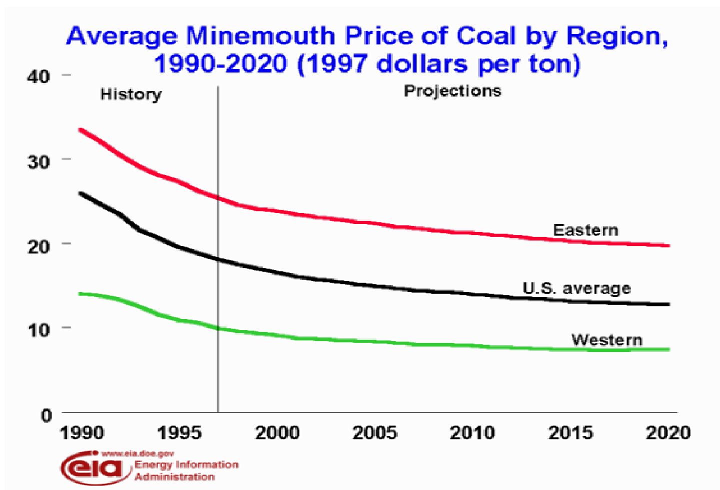
Figure III.M-3



3. Coal Demand and Production Projections

The lower projected coal prices, combined with projected increases in electricity demand, would create increasing demand for coal. This coal demand is subject to a fixed sulfur emissions cap from the Clean Air Act Amendments of 1990, which mandate progressively greater reliance on the lowest sulfur coals (from Wyoming, Montana, Colorado, and Utah). As coal demand grows, however, new coal fired generating capacity is required to use the best available control technology: scrubbers or advanced coal technologies that can reduce sulfur emissions by 90 percent or more. Thus, even as the demand for low sulfur coal grows, EIA predicts that there will still be a market for low cost higher sulfur coal throughout the forecast. From 1997 to 2020, EIA projects high and medium sulfur coal production to increase from 654 to 662 million tons annually (0.1 percent a year), and low sulfur coal production to increase from 445 to 696 million tons annually (2.0 percent a year). As a result of the competition between low sulfur coal and post-combustion sulfur removal, western coal production is projected to continue its historic growth, reaching 772 million tons in 2020. Its growth rate, however, is projected to fall from the 9.4 percent average annual growth achieved between 1970 and 1997 to 1.8 percent average annual growth in the forecast period (USDOE EIA, 1998)

Figure III.M-4



The EIA projects competition from very low sulfur, low cost western and imported coals to limit the growth of eastern low sulfur coal mining. Western low sulfur coal has been successfully tested in all U.S. Census divisions, except New England and the Mid-Atlantic, and its penetration of eastern markets is projected to increase (USDOE EIA, 1998). Projected falling transportation costs are expected to reinforce this trend. The recent history and projected production from eastern and western coal sources is depicted in Figure III.M-5 Coal Production by Region, 1970-2020 (million short tons). The EIA projects that the western production will increase considerably while eastern production remains essentially flat. As for coal exports, EIA projects slow growth for total U.S. coal exports and a slight decline in metallurgical coal exports.

THE EIA PROJECTS COMPETITION FROM VERY LOW SULFUR, LOW COST WESTERN AND IMPORTED COALS TO LIMIT THE GROWTH OF EASTERN LOW SULFUR COAL MINING.

4. Structure of the Coal Industry [1]

During the past decade, the coal industry, often in response to market forces, has undergone major structural changes. The depressed coal market since 1984 and the Clean Air Act Amendments of 1990 (CAAA) induced changes in coal demand patterns that have resulted in (1) the coal industry being increasingly concentrated in ownership and (2) the transformation of coal companies from local and regional companies into nationally based companies.

THE DEPRESSED COAL MARKET SINCE 1984 AND THE CLEAN AIR ACT AMENDMENTS OF 1990 INDUCED CHANGES IN COAL DEMAND PATTERNS THAT HAVE RESULTED IN (1) THE COAL INDUSTRY BEING INCREASINGLY CONCENTRATED IN OWNERSHIP AND (2) THE TRANSFORMATION OF COAL COMPANIES FROM LOCAL AND REGIONAL COMPANIES INTO NATIONALLY BASED COMPANIES.

A lower than expected level of demand for coal has contributed to chronic excess production problems for the coal industry. According to the EIA, the average price for coal at minemouth (in constant dollars) has declined since 1975 and is at a level similar to that in 1970—the pre-oil embargo era (USDOE EIA, 1998). In recent years, some coal producers were reportedly forced to price their products at or below variable costs in order to sell them (DRI/McGraw-Hill). Many marginal coal operations were forced to shut down.

Previously, companies that sold most of their coal under long term contracts could use the profits on these contracts to subsidize spot market sales at prices below average total costs. Most coal contracts include a market reopener clause to allow coal buyers or sellers to renegotiate if the contract price proves to be higher than the market price for similar coals by a predetermined amount. This price mechanism is used to prevent the contract price of coal from escalating too rapidly. However, in a sustained downward market, the market reopener clause in coal contracts has enabled the price of coal to approach the cost of *incremental* production (i.e., the marginal cost) and not the fully loaded cost that includes capital recovery. In such an environment coal producers must become much more efficient so that the cost of production could be lowered.

Another aspect of the changing landscape of the coal industry has been the entry and subsequent exit of oil producers. Many oil companies diversified into the coal business in the 1970's with the expectation of a high return on their investments. The depressed coal price levels and the changing investment environment contributed to the exit of major oil companies from the coal business during the past 5 years. Consequently, many coal properties have changed hands.

Falling coal prices, tight profit margins, and a changing business environment have resulted in a surge of coal industry consolidation and merger activities. The vast majority of the acquisitions during the past 5 years have involved low sulfur or compliance coal properties. While oil companies exited from the coal business, traditional mining companies expanded their coal holdings. Company buyouts and mergers such as Amax and Cypress, Consolidation Coal and Island Creek, and Kennecott's buyout of NERCO and Sun's coal properties have transformed local and regional coal companies into nationwide companies. Since 1982, the coal industry has become much more

[1] The discussion in this section is from the "*Final Economic Analysis of Valid Existing Rights",* U.S. Department of Interior, 1999.

concentrated. In 1982, the top 10 companies accounted for 34 percent of the total U.S. coal production. By 1993, production from the top 10 companies accounted for approximately 45 percent of the total. The continuing coal industry concentration will result in fewer and larger coal suppliers.

The changing business environment brought about by the CAAA and, subsequently, by the deregulation of the electric utility industry mandated by the Energy Policy Act of 1992 has caused the coal companies to reevaluate their long term business strategies. The quality of coal demanded at electric utilities, the largest customers of coal, has changed as electric utilities move from Phase I CAAA compliance in 1995 to Phase II compliance by 2000. In order to survive or to expand their market shares, coal companies will have to be flexible in offering a wide range of products with coal quality varying from high sulfur to low sulfur. Major coal companies are expanding or acquiring coal properties in areas where they did not previously have a presence. As a result, the coal business has become much more national and in some cases even global.

With the exception of only a few short periods in history, the coal industry has otherwise been characterized by overcapacity. The chronic supply/demand imbalance, the dynamics of the coal market, and the relative ease of entry into the coal business have contributed to the competitiveness of the industry. Since the passage of the CAAA, coal market competition intensified. In addition to competition among coal operators in terms of mining methods, geographic locations, and coal qualities, coal must compete with natural gas, foreign coals, and SO_2 emissions allowances. The intensity of competition in today's coal market is unprecedented.

THE HIGH FIXED COSTS OF MODERN COAL MINING REQUIRE HIGH PRODUCTION VOLUMES TO ACHIEVE PROFITABLE UNIT COSTS.

Another trend in coal mining is one towards larger mines. Increasingly complex permitting requirements and the large machinery investments required of modern high productivity mining methods make for high fixed costs. These high fixed costs require high volume production to achieve profitable unit costs.

In West Virginia for example, the largest 22 mines (of 35 total), all produced more than 500,000 tons/yr and jointly accounted for 96 percent of state coal production. Virginia has 52 coal mines, but the largest five produce more than 300,000 tons/yr (Directory of Mines 1998) and account for 92 percent of state coal production (VA DMME 1998). In Kentucky, the largest 49 of 195 total mines produce more than 300,000 tons/yr and account for 68 percent of state coal production (VA DMME 1998).

N. PAST AND CURRENT MINING IN THE STUDY AREA

Coal production within the steep slope areas of West Virginia, Kentucky and Virginia closely follows the historical trend of the overall United States coal mining industry. In general, coal production in the United States increased annually due to increased mechanization of the industry from 1890 to the great depression of the 1930s, when production dropped off significantly. Coal production began to increase again with the onset of World War II and continued increasing until after the Korean conflict. In 1954, the railroad industry's conversion from coal to diesel fuel brought a modern low point in coal production. Since then, annual coal production has generally increased or remained stable.

Tables III.N-1, III.N-2 and Figure III.N-1 present data on coal production for the study area, using data from the Energy Information Administration (EIA). The discussion below highlights some of the notable statistics contained in these tables. The EIA data do not distinguish among the different types of surface mining methods. Based on research conducted by Hill and Associates (2000) and by Resource Technologies Corporation (2000), roughly 95 percent of the surface mining in southern West Virginia would be classified as the MTM/VF mining that is the subject of this EIS. The proportions for eastern Kentucky, Virginia, and Tennessee are not known.

Table III.N-1
Coal Production Trends by State, Region, and U.S. (Thousand Short Tons)

Coal-Producing State and Region	1989	1994	1998	Avg. Annual Percent Change	
				1994-1998	1989-1998
Kentucky Total	167,389	161,642	150,295	-1.8	-1.2
Eastern	125,739	124,447	116,654	-1.6	-.8
Western	41,649	37,195	33,641	-2.5	-2.3
Tennessee	6,480	2,987	2,696	-2.5	-9.3
Virginia	43,006	37,129	33,747	-2.3	-2.6
West Virginia Total	153,580	161,776	171,145	1.4	1.2
Northern	56,018	49,316	44,618	-2.5	-2.5
Southern	97,562	112,460	126,527	3.0	2.9
Study Area Total	272,787	277,023	279,624	0.2	0.3
State Totals	370,455	363,534	357,883	-0.4	-0.4
U.S. Total	980,729	1,033,504	1,117,535	2.0	1.5

Source: Energy Information Administration. 2000 - http://www.eia.doe-gov/cneaf/coal/cia/special/t1p01p1.html

Southern West Virginia is the only portion of the study area to have experienced higher coal production in 1994 and 1998 than in 1989.

Figure III.N-1
Coal Production, 1998

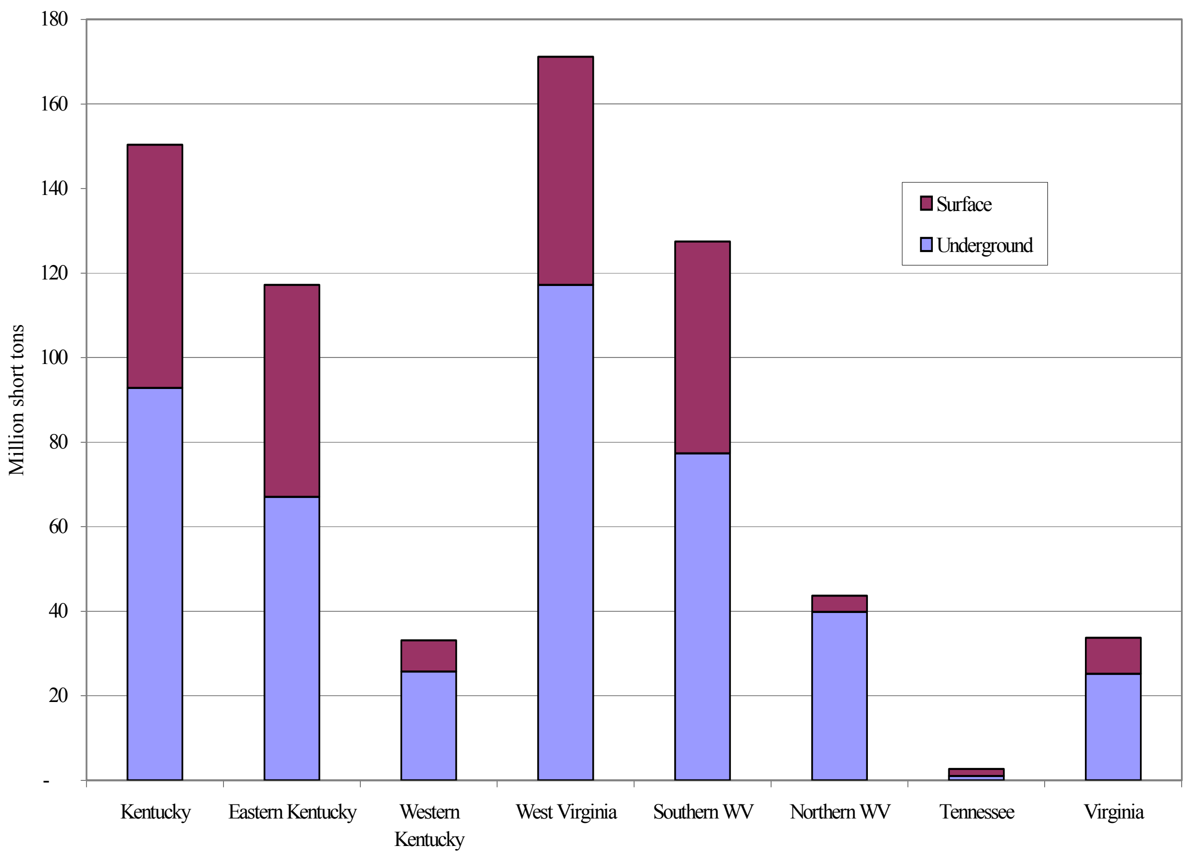


Table III.N-2
Coal Production and Number of Mines by State, County, and Mine Type, 1998
(thousand short tons)

Location	Underground		Surface		Total	
	Mines	Production	Mines	Production	Mines	Production
Kentucky	277	92,832	205	57,462	482	150,295
Eastern Tier	**259**	**67,066**	**186**	**49,589**	**445**	**116,654**
Bell	12	3,390	10	2,130	22	5,520
Breathitt	–	–	5	4,302	5	4,302
Clay	1	25	5	348	6	373
Floyd	31	2,426	8	3,258	39	5,684
Harlan	29	6,629	10	1,502	39	8,131
Jackson*	–	–	1	3	1	3
Johnson	3	1,100	3	37	6	1,137
Knott	25	5,119	19	3,943	44	9,061
Knox	11	399	6	188	17	587
Lawrence	1	145	4	130	5	275
Leslie	8	7,470	7	2,167	15	9,637
Letcher	15	6,519	23	3,342	38	9,860
Magoffin	–	–	2	819	2	819
Martin	24	6,530	11	5,048	35	11,578
Owsley	–	–	3	50	3	50
Perry	14	5,755	17	8,729	31	14,484
Pike	82	21,420	49	13,470	131	34,890
Whitley	3	139	3	125	6	264
Tennessee	**13**	**1,047**	**14**	**1,649**	**27**	**2,696**
Anderson	2	16	–	–	2	16
Campbell	2	470	5	382	10	852
Claiborne	4	503	4	435	8	937
Cumberland	–	–	1	86	1	86
Fentress	–	–	2	211	2	211
Morgan	1	11	–	–	1	11
Scott	1	47	–	–	1	47
Sequatchie	–	–	2	537	2	537

Table III.N-2
Coal Production and Number of Mines by State, County, and Mine Type, 1998 (thousand short tons)
(Continued)

Location	Underground		Surface		Total	
	Mines	Production	Mines	Production	Mines	Production
Virginia	**127**	**25,212**	**46**	**8,535**	**173**	**33,747**
Allegheny	–	–	1	109	1	109
Buchanan	55	10,941	9	1,537	64	12,477
Dickenson	14	2,271	8	971	22	3,242
Lee	5	1,057	2	169	7	1,225
Russell	6	809	2	415	8	1,224
Tazewell	12	1,807	–	–	12	1,807
Wise	35	8,327	24	5,335	59	13,662
West Virginia	**246**	**117,191**	**100**	**53,955**	**346**	**171,145**
Southern Tier	**213**	**77,954**	**73**	**48,572**	**286**	**126,527**
Boone	30	21,066	8	8,420	38	29,486
Braxton	1	588	–	–	1	588
Clay	–	–	4	6,636	4	6,636
Fayette	3	1,358	4	1,993	7	3,351
Greenbrier	2	496	3	30	5	526
Kanawha	10	4,647	6	9,478	16	14,126
Lewis	–	–	1	1	1	1
Lincoln	1	24	–	–	1	24
Logan	21	3,814	8	10,305	29	14,119
McDowell	63	4,4343	10	1,901	73	6,244
Mingo	27	16,160	14	6,249	41	22,409
Nicholas	6	2,015	4	749	10	2,764
Raleigh	20	12,376	2	109	22	12,486
Wayne	4	3,366	2	1,024	6	4,390
Webster	5	2,147	2	2,586	7	4,733
Wyoming	20	8,289	5	1,679	25	9,967

*Surface Production rounded to zero

Source: Energy Information Administration, 2000. htp:www.eia.doe.gov/cneaf/coal/cia/special/tb104p01.txt

1. Kentucky

Kentucky had the third highest state coal production rate in 1998. The 150.3 million short tons produced in Kentucky comprised over 13 percent of the domestic coal production (Table III.N.-1). Eastern Kentucky is the dominant of the state's two coal mining regions, producing 117.2 million short tons in 1998, or 78 percent of the total state production. Production in eastern Kentucky has decreased at an average annual rate of -0.8 percent from 1989 to 1998. Production in western Kentucky has also decreased, resulting in a slight net decrease (-1.2 percent) for the state overall over the period. The four eastern Kentucky counties of Pike, Martin, Letcher, and Perry account for 47 percent of the total state production (Table III.N.-2). In 1998, the top producing mine in the state was Lodestar Energy's No. 13 Baker underground mine, with 4.39 million short tons of coal.

SURFACE MINING ACCOUNTS FOR 42.5 PERCENT OF THE COAL PRODUCTION IN EASTERN KENTUCY IN 1998. THE TOP SURFACE MINING COUNTIES IN 1998 WERE PIKE, PERRY, AND MARTIN

In 1998, eastern Kentucky surface coal mines produced 49.6 million short tons from 186 mines (Table III.N.-2), that accounted for 33 percent of the total state coal production and 42.5 percent of eastern Kentucky production. Eastern Kentucky had 259 operating underground mines in 1998, producing 67 million short tons of coal. Coal production from Kentucky underground mines has increased less than 1 percent annually from 1988 to 1997. The continuous mining method produces the majority (74.9 million short tons) of coal mined by underground methods (USDOE EIA, 1998).

The eastern Kentucky coalfields are located in 30 counties consisting of 7.2 million acres. There are 2,295 permanent program permits with 1,361,145 permitted acres in these counties. Of these, 936 permits are surface mining operations with 386,945 acres permitted. These surface mining operations use a variety of mining techniques (i.e. contour, remine, auger, area, mountaintop removal, and any combination of these mine types).

Mountaintop removal and steep slope variance mines are a subset of all surface mines. There are 395 such mines with permanent program permits, amounting to 88,653 permitted acres with permanent program permits. From this total, 219 permits are in an active status, 149 permits have had either a Phase I or a Phase II bond release, and the status of the remaining 27 permits varies. This acreage represents approximately 1.2 percent of the land area in the 30 counties of the eastern Kentucky coal field. These active mountaintop removal/steep slope variance permits account for 6.5 percent of permitted acreage and approximately 17.2 percent of all permanent program permits in the eastern Kentucky coal field.

2. Tennessee

Tennessee is a minor coal producing state, contributing less than one percent of the total U.S. coal production in 1998 (USDOE EIA, 1998). From 1989 to 1994, coal production fell to less than one-half its 1989 level and has decreased slightly since then. The EIA reported production of 1.65 million short tons from 14 surface mines in 1998, accounting for 61 percent of total state coal production. The two largest surface mined coal producing counties in 1998 were Sequatchie, with 537 thousand short tons, and Claiborne, with 435 thousand short tons.

3. Virginia

In 1998, Virginia had the ninth highest coal production of all states at 33.7 million short tons, or 3 percent of the domestic coal production (see Table III.N-1). Virginia coal production has been on a downward trend, having decreased almost 3 percent annually since 1989 (Table III.N-1). The counties of Buchanan and Wise account for over 77 percent of the state's coal production. In 1998, the top producing mine in the State was CONSOL's Buchanan No. 1 underground coal mine, with 4.3 million short tons of coal.

Virginia had 46 operating surface mines in 1998, producing 8.5 million short tons of coal (Table III.N-2) that accounts for 25 percent of the total state production. While overall coal production has decreased, coal produced by surface mining methods increased by 1.1 percent from 1988 to 1997.

Virginia had 127 underground coal mines producing 25.2 million short tons in 1998 (Table III.N-2). This figure accounts for 75 percent of Virginia's coal production. Coal produced from underground mining methods decreased 3.7 percent annually from 1988 to 1997. The continuous mining method was used in the production of 55 percent of the coal produced from underground mines in 1998 (USDOE EIA, 1998).

4. West Virginia

In 1998, West Virginia had the second highest coal production rate of all states at 171.1 million short tons, or over 15 percent of the total nation's output (Table III.N-2). Mineable coal seams occur in 43 of the state's 55 counties. There are 117 identified coal seams in the state; of these, 62 seams are mineable using current technology.

Coal production in southern West Virginia was 126.5 million short tons in 1998, accounting for 74 percent of the state total. While production in northern West Virginia has decreased, production in southern West Virginia has increased at an average annual rate of 2.9 percent from 1989 to 1998, resulting in a net increase in production for the state overall. The four southern West Virginia counties of Boone, Logan, Mingo, and Kanawha account for 47 percent of the total state coal production. West Virginia's highest producing mine is Mingo-Logan Coal's Mountaineer Mine, an underground mine that produced 7.5 million short tons, placing it as the 20th most productive mine in the nation in 1998. The state's top producing surface mine is Samples' Caternary Coal Mine, which produced 4.95 million short tons and ranked 42nd in the nation in 1998 (USDOE EIA, 1999).

Surface mining in southern West Virginia typically occurs at a much larger scale than in neighboring states, with an average production of 684 thousand tons per mine in 1998, compared to 267 thousand tons per mine in eastern Kentucky, 118 thousand tons per mine in Tennessee, and 186 thousand tons per mine in Virginia.

SURFACE MINING ACCOUNTED FOR 40 PERCENT OF SOUTHERN WEST VIRGINIA COAL PRODUCTION IN 1998. THE TOP SURFACE MINING COUNTIES IN 1998 WERE LOGAN, KANAWHA, BOONE, CLAY, AND MINGO.

Coal production by surface mining methods in West Virginia has increased by 6 percent from 1983 to 1997. The most common surface mining methods in the state are contour, mountaintop removal, and multiple seam operations. Southern West Virginia had 71 operating surface mines in 1998, producing 48.6 million short tons of coal (Table III.N-2). This production accounted for 30 percent of the state's total and 40 percent of all southern West Virginia coal production in 1998. The top surface mining counties in 1998 were Logan, Kanawha, Boone, and Clay and Mingo.

Underground mines in southern West Virginia produced 77.9 million short tons of coal from 209 mines [Table III.N-2]. Coal production from southern West Virginia underground mines accounts for 46 percent of the state's coal production and approximately 60 percent of all southern West Virginia coal production. Underground mining in southern West Virginia, using the continuous mining method, produced 52.0 million short tons in 1998 accounting for nearly two-thirds of all underground mining in that region of the state and 30 percent of the state's total coal output.

O. THE SCOPE OF REMAINING SURFACE-MINABLE COAL IN THE STUDY AREA

1. Demonstrated Coal Reserves

The Energy Information Administration provides an estimate of the demonstrated reserve base of coal in each state, by most likely type of mining method. This EIS deals only with the Appalachian region and bituminous coal seams, where the "demonstrated reserve base" consists of the portion of coal seams that are at least 28 inches thick and no greater than 1,000 feet deep. The demonstrated coal reserve information, as of 1996, is displayed in Table III.O-1. The data in this table includes demonstrated reserves outside of the EIS study area in portions of northern West Virginia and western Kentucky.

Table III.O-1
Coal Reserves and Remaining Production Life

	Demonstrated Reserve Base (million short tons)			Remaining Years of Production	
Region	**Underground**	**Surface**	**Total**	**Underground**	**Surface**
Kentucky	1,400	5,600	7,000	19	108
West Virginia	16,800	2,800	19,600	144	49
Tennessee	300	200	500	215	105
Virginia	900	500	1,400	33	49
Four-state Total	19,400	9,100	28,500	na	na
U.S. Total	122,900	151,900	273,900	na	na

Source: U.S. Dept. of Energy, Energy Information Administration, 1998. Coal Industry Annual, 1997.

2. Remaining Extent of Major Surface Minable Coal Seams

a. Introduction

The EIS Steering Committee commissioned several studies to determine the extent of remaining surface mineable coal seams. The seams analyzed account for the majority of current surface mining production as well as the potential future production in eastern Kentucky, central/southern West Virginia, and southwestern Virginia. Defining the location of these seams allows a spatial representation where likely future surface coal mining will result in the types of aquatic, community and terrestrial impacts described and analyzed in other sections of this EIS. One of the principle impacts evaluated by this EIS is excess spoil disposal in valley fills. Portraying the location of remaining surface mineable coal also generally identifies the potential areas where valley fills could occur.

b. Methodology

Information on surface mineable coal zones in Kentucky was provided to OSM under contract with Dr. Jerry Weissenfluh of the Kentucky Geologic Survey (KGS). Nick Fedorko of the West Virginia Geologic and Economic Survey (WVGES) prepared the data for West Virginia coal seams at the direction of the West Virginia Legislature. Dr. Eric C. Westman, Department of Mining and Mineral Engineering, Virginia Polytechnic Institute and State University (VPI), prepared the information for Virginia under contract to OSM. The following reports were provided to OSM , and, as described below, used to prepare the map in this section. The individual reports and GIS coverages are available from OSM or the authors.

b.1. West Virginia

WVGES prepared "Projecting Future Coal Mining in Steep Terrain of Appalachia, " May 2000. The report identifies three surface mineable coal zones in central/southern West Virginia. The coal zones selected by WVGES were based on a review of past and current mining trends, coupled with the general knowledge of the remaining extent of surface mineable seams. WVGES concluded that future surface mining activity will involve the Coalburg coal zone (Coalburg, Stockton and associated riders) and/or the overlying 5 Block coal zone (includes 5 Block, 6 Block and 7 Block). Using standard geologic techniques and a geographic information system (GIS), the contour or outcrop of the Coalburg and 5-Block coals were mapped as a GIS layer for each of the USGS topographic quadrangles in the West Virginia portion of the EIS study area.

Information on areas of existing permitted surface or underground mines and previously mined out areas for each of the coal zones were obtained by WVGES from the West Virginia Division of Environmental Protection and the mining industry. The past and current mining extent was also stored as a GIS cover. OSM developed the areas of remaining coal, using the GIS, by subtracting the mined out and permitted areas from the coal zone extent GIS coverage [see Figure III.O-1].

b.2. Kentucky

KGS submitted "Estimation of Future Mountain-Top Removal Areas in the eastern Kentucky," July 2000. The report covers three surface mineable coal zones in Eastern Kentucky. The outcrop of the Richardson, Broas, and Peach Orchard coal seams were mapped in a GIS coverage. KGS selected this interval because of the historical importance and likely remaining extent of these coals.

Information on areas of existing permitted surface or underground mines and previously mined out areas for each of the coal zones were obtained by KGS from the Kentucky Department of Mines, Department for Surface Mining Reclamation and Enforcement, and the mining industry. The past and current mining extent was also stored as a GIS cover. OSM developed the areas of remaining coal, using the GIS, by subtracting the mined out and permitted areas from the coal zone extent GIS coverage [see Figure III.O-1].

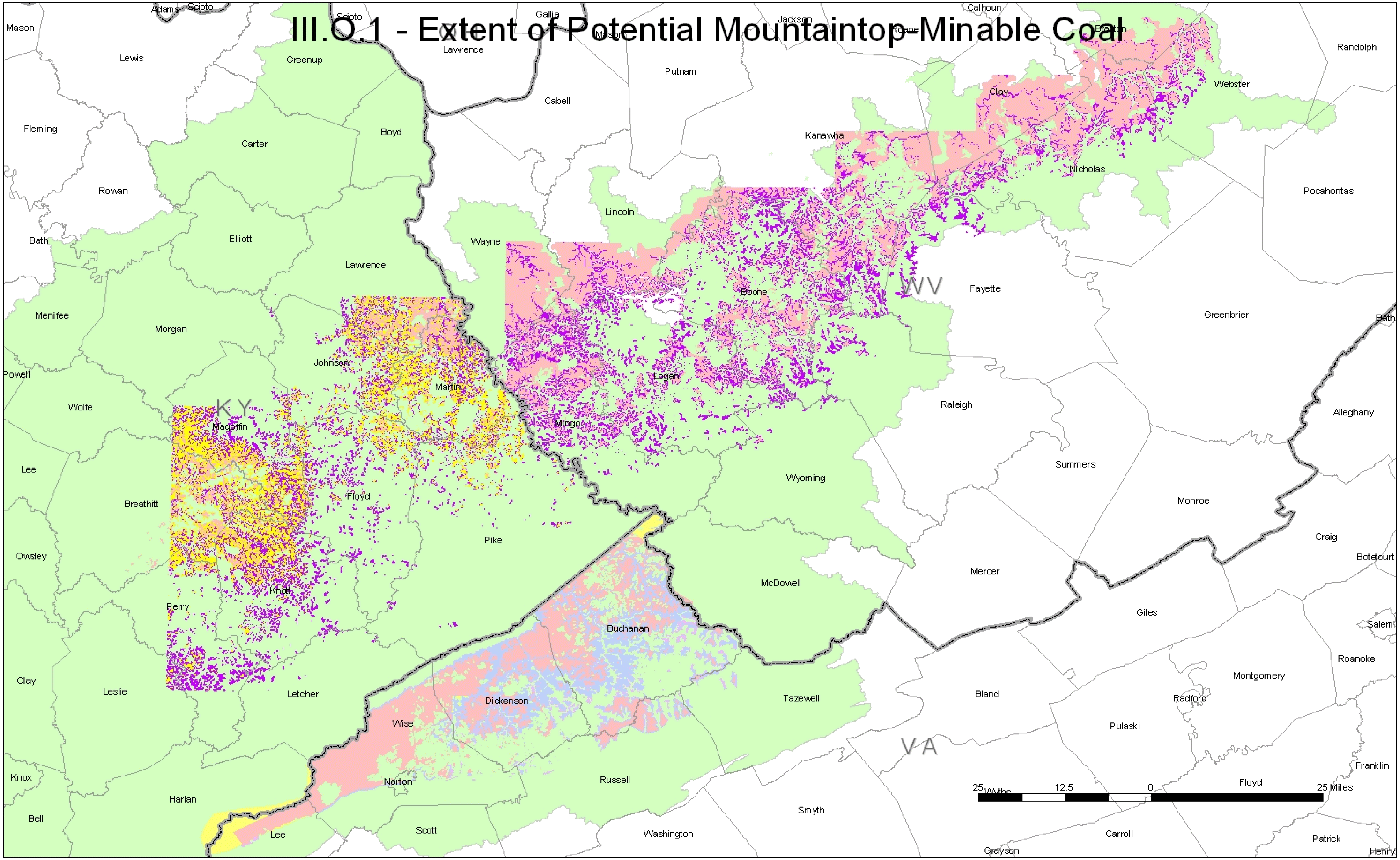
b.3. Virginia

VPI provided the report, "Estimation of South Western Virginia Reserve Base of Surface Mineable Coal," July, 2000. Five coal seams with potential for surface mining were identified based on information obtained from the mining industry and the Virginia Department of Mines, Minerals, and Energy and its Division of Mined Land Reclamation (VADMLR). The seams assessed were the Blair, Dorchester, Norton, Upper Banner, and Lower Banner. The outcrop and extent of these seams were mapped in a GIS coverage.

Information on areas of existing permitted surface or underground mines and previously mined out areas for each of the coal seams were obtained by VPI from the VADMLR and the mining industry. The past and current mining extent was also stored as a GIS cover. OSM developed the areas of remaining coal, using the GIS, by subtracting the mined out and permitted areas from the coal seam extent GIS coverage [see Figure III.O-1].

3. Geologic Extent of Remaining Mountaintop-Minable Coal in the EIS Study Area

It is very important to note that the extent of coal shown on map III.O-1 is <u>not</u> necessarily the extent of future surface mining [see Figure III.O-1]. The maps merely show the extent of coal seams that <u>could</u> be surface mined. The actual mining areas are dependent on the consistency of the coal bed, thickness, stripping ratio, coal quality, size of coal reserve block, and other factors used in site specific mining feasibility analysis. Thus, the areas that will actually be mined will likely be much smaller than the extent of the seam shown.


III.O.1 - Extent of Potential Mountaintop-Minable Coal
KY
WV
VA
Mason
Lewis
Fleming
Rowan
Bath
Menifee
Powell
Wolfe
Lee
Owsley
Clay
Knox
Bell
Adams
Scioto
Greenup
Carter
Elliott
Morgan
Breathitt
Leslie
Harlan
Boyd
Lawrence
Johnson
Magoffin
Floyd
Knott
Perry
Letcher
Martin
Pike
Gallia
Cabell
Wayne
Lincoln
Putnam
Mason
Jackson
Kanawha
Boone
Logan
Mingo
Roane
Calhoun
Clay
Braxton
Webster
Nicholas
Randolph
Pocahontas
Greenbrier
Fayette
Raleigh
Wyoming
McDowell
Mercer
Summers
Monroe
Bath
Alleghany
Craig
Botetourt
Salem
Roanoke
Giles
Montgomery
Radford
Pulaski
Bland
Tazewell
Buchanan
Dickenson
Wise
Norton
Russell
Scott
Lee
Washington
Smyth
Wythe
Grayson
Carroll
Floyd
Franklin
Patrick
Henry
25
12.5
0
25 Miles

P. DEMOGRAPHIC CONDITIONS

1. Population

From 1980 to 1990, the total population of the study area counties fell by over 140,000, from 2.11 million to 1.97 million–a 6.7 percent decrease. In contrast, the population of each of the states—with the exception of West Virginia—grew over this period. Regarding West Virginia, the study area counties lost population at a substantially greater rate than the state overall—1.4 percent per year compared to 0.7 percent per year for the state. Census estimates for 1998 indicate that the study area's population levels have slightly rebounded to total 2,014,466. Tennessee is the only state in which the study area counties have regained their 1980 population. Total population in the West Virginia study area has declined from 1990-1998, although at a slower rate than the previous decade.
With the exception of West Virginia, the study area population density of each state portion is below that of the state overall. West Virginia's study area counties show similar population densities to the state overall, which are lower than those of the other states encompassing the study area.

The population within the study area may be characterized as predominantly white and non-Hispanic. From 1980 to 1990, the majority of the counties within the study area experienced slight increases in minority levels. Statewide, West Virginia has the lowest proportion of population as minorities. On the other hand, the study area portion of West Virginia shows some of the highest percentage of minorities of all study area counties; five of the study area counties in West Virginia had more than five percent of their population as minority in 1990.

2. Education Levels

For purposes of this EIS, educational attainment was measured as the percentage of the population over age 25 that have not earned a high school diploma. Census data for 1990 indicate that the study area counties lag behind their states in educational attainment as measured by this statistic. On the positive side, educational attainment had increased from 1980 to 1990. However, only some of the study area counties were narrowing the educational gap with their state average; the counties did not show a consistently greater decrease than the state average in the percent of the population without a high school diploma.

3. Income and Poverty Levels

Income Statistics from the 1980 and 1990 Censuses indicate that the study area, as a whole, has a starkly lower income than the individual states. Just four of the sixty-nine study area counties had a per capita income exceeding its state average per capita income in 1990. Moreover, in most study area counties, per capita income grew more slowly from 1980 to 1990 than in the state. Among the states, West Virginia had the lowest per capita income in 1990 and the slowest growth from 1980 to 1990.

Another measure of economic well-being is the estimated percentage of the population with an income below the poverty level. Census statistics for 1980 and 1990 starkly depict a poverty problem throughout most of the study area. The statewide percentage of the population living below the poverty level increased in West Virginia between 1980 and 1990. The poverty rate in all study area counties in West Virginia grew between 1980 and 1990 and in 1990 all but one of these counties had a higher poverty rate than the statewide rate of 19.7 percent. Over the entire study area, only four of the counties had a lower poverty rate than their respective state and only ten had a poverty rate below twenty percent in 1990. In twenty-four of the study area counties, over one in every three residents was estimated to live below the poverty level.

4. Analysis of Census Statistics for Select Communities

a. Introduction

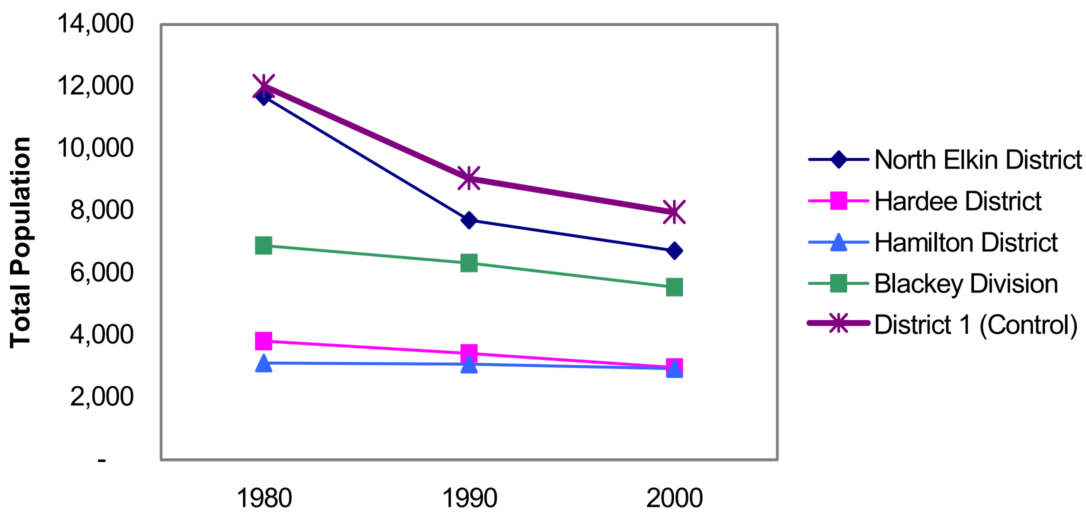
This section summarizes some of the key socioeconomic data presented in the "Case Studies Report on Demographic Changes Related to Mountaintop Mining". The purpose of this report was to evaluate what, if any, demographic changes can be observed in communities located adjacent to large-scale surface mining operations. The demographic evaluations presented for these communities were based on three decades of census data (i.e., the 1980, 1990, and 2000 decennial censuses) in order to assess the demographic trends that have occurred over time: prior to the introduction of large-scale surface mining operations adjacent to the case study community (i.e., 1980), during large-scale surface mining (i.e., 1990), and after large-scale surface mining (i.e., 2000).
The case study areas include one control area which was selected as similar to others in demographic , geographic conditions and economic resources but within which very little or no significant surface mining had taken place within the time period identified in the study. The case study communities were as follows:

- Hamilton District, community of Werth, Nicholas County, WV
- North Elkin District, community of Kyle, McDowell County, WV
- Hardee District, community of Naugatuck, Mingo County, WV
- Hardee District, community of Scarlet, Mingo County, WV
- Blackey Division, community of Carcassonne, Letcher County, KY
- District One, Wyoming County, WV as the Control Area.

b. Total Population Growth Trends

As illustrated in Figure III.P-1, the study area districts, including the control district, experienced decreases in their total populations over three mountaintop mining periods. The sharpest decrease for the North Elkin and District 1 (control community) districts occurred between the 1980 (prior) and 1990 (during) periods. The population decreases experienced by these census districts are similar to the trends enumerated for their respective counties; that is, the rate of population decline was greater over the 1980 to 1990 period than the 1990 to 2000 period. These trends may, in part, be attributed to an increase in net out-migration patterns, which is most likely associated with the downturn in the local economy that caused local residents to migrate elsewhere to seek employment opportunities.

Figure III.P-1
Total Population Growth Trends



c. Age Group Composition

Figures III.P-2 and III.P-3 illustrate that the case study communities' populations are aging. Figure III.P-2 illustrates that the proportion of school age group populations steadily decreased over the three census periods for each case study community. Combined with the overall population decline, this proportional decline indicates that the school age population as experienced an absolute increase over the two periods. While the school-age proportion of the populations has declined, the proportion that is of senior age has increased. The increase in the median age level (Figure III.P-4) for the case study communities is further evidence of this aging trend. Therefore, it is highly probable that the local communities will have a population base that is less in need of public school facilities but more dependent on transfer payments, such as social security and public assistance funds; thereby, creating a population having a decreased level of purchasing power and a greater dependence on specialized and public assistance services.

Figure III.P-2
Population Composition Trends - School Age Groups

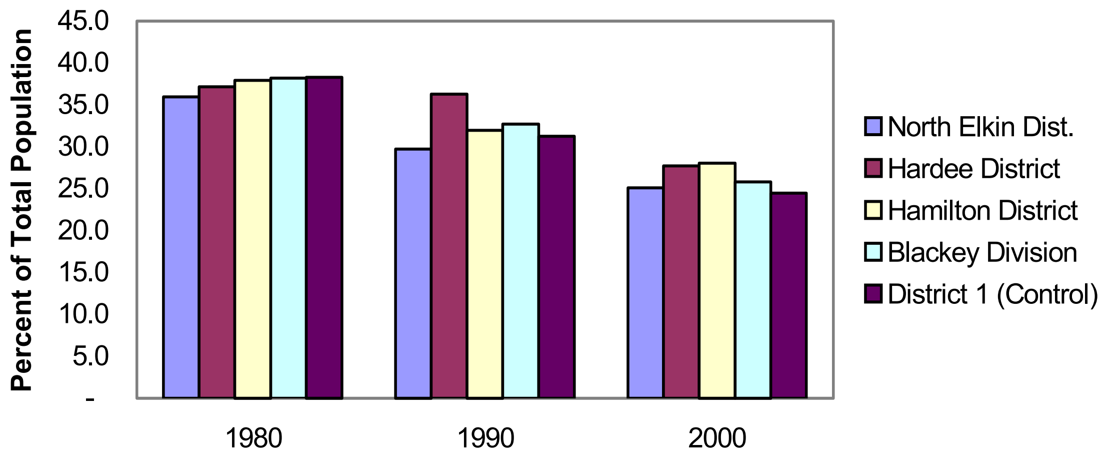
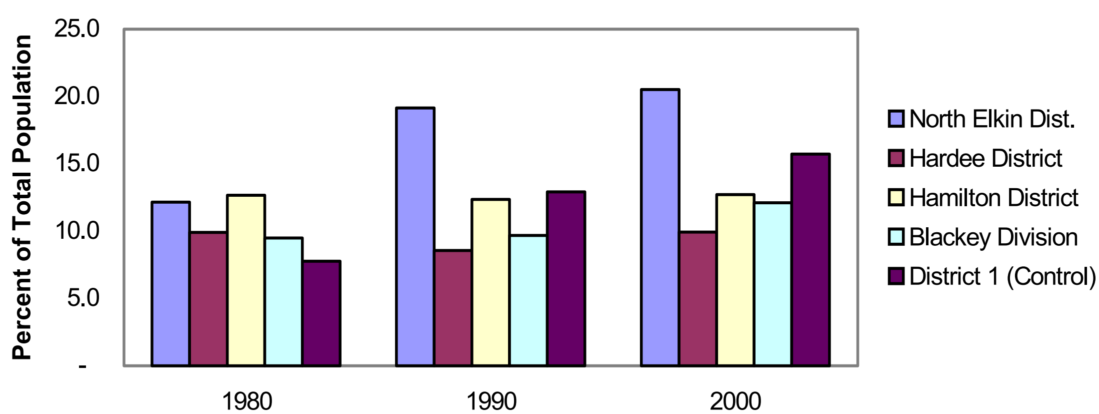
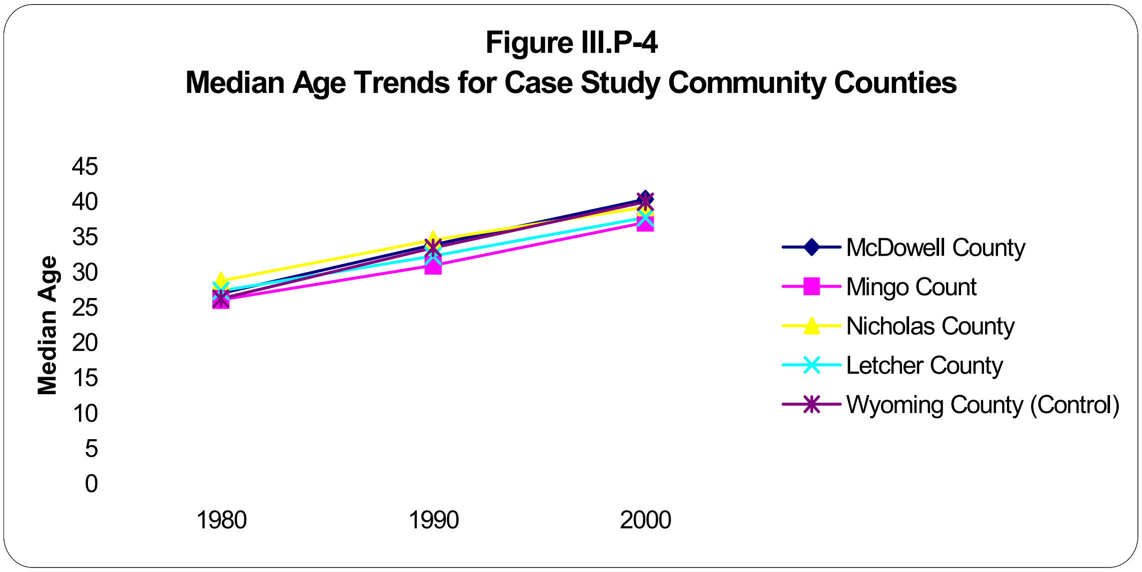


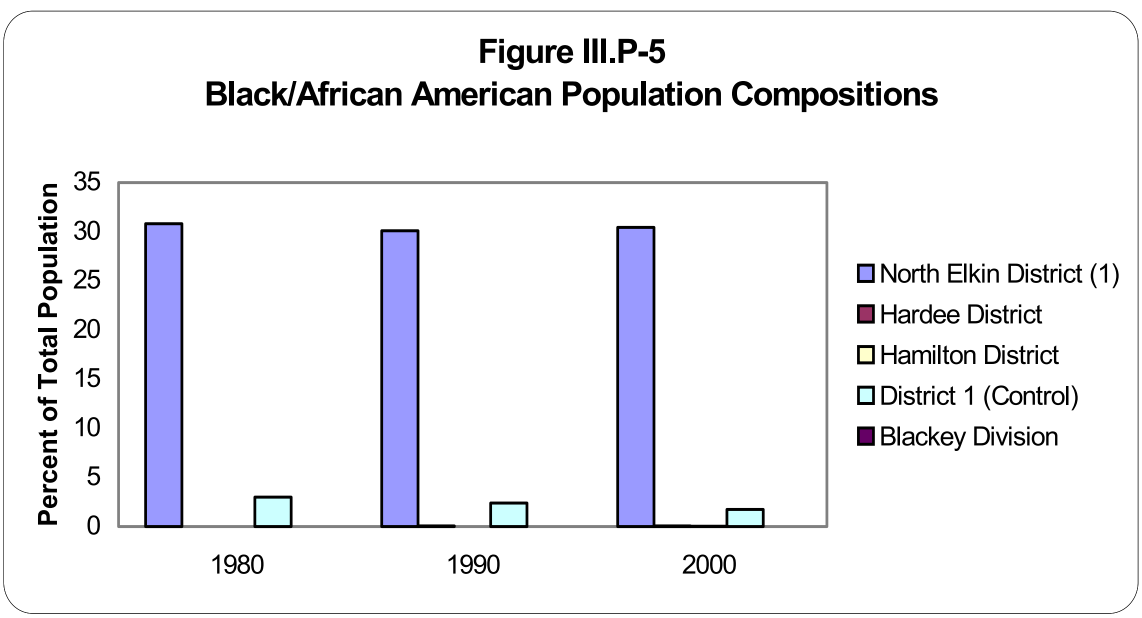
Figure III.P-3
Population Composition Trends - Senior Age Groups





d. Racial Composition

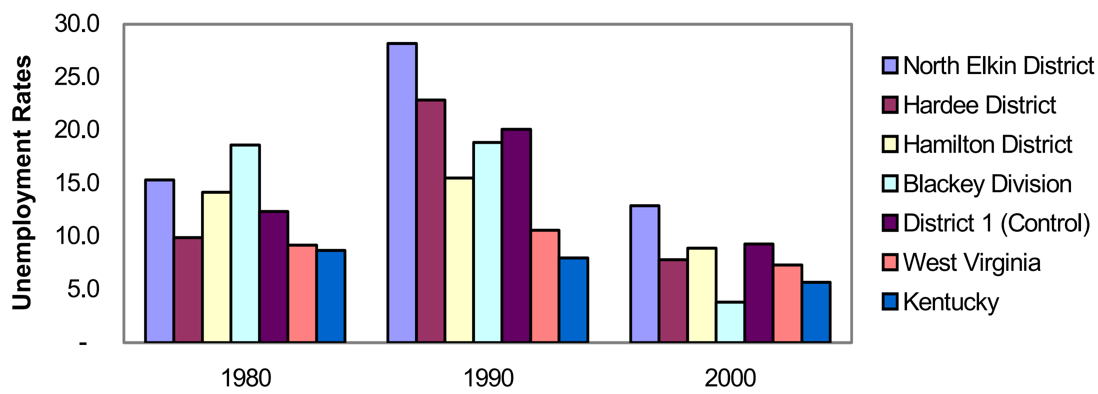
According to the 1980, 1990, and 2000 Censuses, the two largest racial groups comprising the case study communities are whites and Black/African Americans. As illustrated in Figure III.P-5, however, whites comprised a significantly larger share of the case study community populations than blacks/African Americans over the three mountaintop mining periods. The exception to this trend is noted for the North Elkin District (Kyle case study). Black/African American populations are more likely to be impacted by mountaintop mining operations in the North Elkin District compared to the remaining case study communities.



e. Poverty Levels and Unemployment Rates

Figure III.P-6 illustrates unemployment rate comparisons and trends for the case study communities and the states. With one exception (Blackey Division, KY, in 2000), unemployment rates in the communities exceed the state average unemployment rates, with the divergence being the most pronounced in 1990. Unemployment rates have decreased substantially for all studied geographic units over the 1990-2000 time period.

Figure III.P-6
Unemployment Rate Trends



Consistent with the unemployment data, poverty rates in the communities exceed the rates in their respective states for all time periods. Poverty rates increased from 1980 to 1990, but decreased for all but one community for the period 1990-2000. The movements in unemployment and poverty rates for the control community paralleled the movements for the case studies communities; thus, these data offer no evidence that the large-scale surface mining had an effect on these measures of economic well-being.

5. Environmental Justice Populations

a. Regulatory Background

Executive Order (EO) 12898 addresses how executive agencies are to consider environmental justice in their decision-making. The executive order specifies federal agency responsibilities to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. Specifically, the executive order requires federal agencies to:

- Conduct their programs, policies, and activities that substantially affect health and the environment so as not to exclude, deny benefits to, or discriminate against persons because of race, color, or national origin.

- Ensure that public documents, notices, and hearings relating to human health or the environment are concise, understandable, and readily accessible to the public.

- Whenever practicable and appropriate, collect, maintain, and analyze information assessing and comparing environmental and human health risks borne by populations identified by race, national origin, or income. To the same extent, Federal agencies shall use this information to determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. Similarly, Federal agencies are to collect and analyze information on race, national origin, income level, and other readily accessible and appropriate information for areas surrounding facilities or sites expected to have a substantial environmental, human health, or economic effect on the surrounding populations, when such facilities or sites become the subject of a substantial federal environmental administrative or judicial action.

- Collect and analyze information on the consumption patterns of populations who principally rely on fish and wildlife for subsistence.

The Council on Environmental Quality (CEQ) has published guidance regarding federal agency NEPA analyses addressing environmental justice. The CEQ guidance notes that the Executive Order recognizes the importance of research, data collection, and analysis, particularly with respect to multiple and cumulative exposures to environmental hazards for low-income populations, minority populations, and Indian tribes. Thus, data on these exposure issues should be incorporated into NEPA analyses as appropriate. Second, the guidance notes that the EO requires agencies to work to ensure effective public participation and access to information. Third, the guidance references the presidential memorandum accompanying the EO, and states that the memorandum identifies important ways to consider environmental justice under NEPA.

In addition, state regulatory programs, while not specifically required to comply with EO 12898, must still comply with all federal laws that provide the statutory framework for environmental justice. To obtain federal funding, state regulatory authorities must certify to OSM that they will comply with all federal statutes relating to nondiscrimination. For example, states must certify compliance with Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which “prohibits discrimination on the basis of race, color or national origin.”

b. Demographic Data Pertinent to Environmental Justice Populations

Environmental Justice statistics on the study areas’ populations were collected from the 1980 and 1990 Censuses. These statistics focus on three environmental justice parameters–poverty levels, per capita income levels, and minority population levels. The following narratives present statistical evidence of the degree to which the environmental justice populations exist within the study area. Note that due to programmatic nature of this EIS, it is not feasible to identify specific mining operations and any specific environmental justice populations that may be impacted.

b.1. Poverty Levels

Census statistics for 1980 and 1990 identify an environmental justice population based on the poverty level data presented in Table III.P-1, which starkly depicts a poverty problem throughout most of the study area counties located within the states of Kentucky, Tennessee, Virginia, and West Virginia. The statewide percentage of the population living below the poverty level increased in West Virginia between 1980 and 1990. The poverty rate in all study area counties in West Virginia grew between 1980 and 1990, and in 1990 all but one of these counties had a higher poverty rate than the statewide rate of 19.7 percent. Over the entire study area, only four of the counties had a lower poverty rate than their respective state and only ten had a poverty rate below twenty percent in 1990. In twenty-four of the study area counties, over one in every three residents is estimated to live below the poverty level.

A more compelling analysis of impoverished communities is detailed in the report funded by the Appalachian Regional Commission (ARC) entitled, "Recent Trends in Poverty in the Appalachian Region: The Implications of the U.S. Census Bureau Small Area Income and Poverty Estimates on the ARC Distressed Counties Designation" (2000). This report examines the Census Bureau's *Small Area Income and Poverty Estimates* effects on the ARC *distressed county* designation. According to this report, the greatest number of study area ARC distressed counties in 1980 were located in Kentucky (32 distressed counties or 65.3 percent of the state total), followed by Tennessee (16 distressed counties or 32 percent of the state total). In 1990, Kentucky continued to lead the study area states and increased its number of ARC distressed counties to 37 (75.5 percent of the state total). Tennessee, however, experienced a decrease in the number of distressed counties with only nine (18 percent of the state total) in 1990. Conversely, West Virginia experienced a significant increase in the number of ARC distressed counties; in 1990 the state had 27 distressed counties (49.1 percent of the state total).

Table III. P-1
ARC Distressed Counties by State, 1980 and 1990

State	ARC	1980 Distressed		1990 Distressed		Change	
	Counties	#	%	#	%	#	%
Alabama	35	3	8.6	7	20.0	4	133
Georgia	35	1	2.9	0	0.0	-1	-100
Kentucky	49	32	65.3	37	75.5	5	16
Maryland	3	0	0.0	0	0.0	0	0
Mississippi	21	6	28.6	13	61.9	7	117
New York	14	0	0.0	0	0.0	0	0
North Carolina	29	3	10.3	2	6.9	-1	-33
Ohio	29	2	6.9	7	24.1	5	250
Pennsylvania	52	0	0.0	0	0.0	0	0
South Carolina	6	0	0.0	0	0.0	0	0
Tennessee	50	16	32.0	9	18.0	-7	-44
Virginia	21	1	4.8	3	14.3	2	200
West Virginia	55	7	12.7	27	49.1	20	286
Total	**399**	**71**	**17.8**	**105**	**26.3**	**34**	**48**

Source: Appalachian Regional Commission, 2000 b.2. Per Capita Income

Table III.P-3 reveals that the per capita income levels of the majority of the study area counties are starkly lower than the per capita income levels of their respective states. Just four of the sixty-nine study area counties had a per capita income exceeding their respective state average per capita income in 1990. Moreover, in most study area counties, per capita income grew more slowly from 1980 to 1990 than in the state. Among the states, West Virginia had the lowest per capita income in 1990 and the slowest growth from 1980 to 1990.

b.3. Minority Populations

The population within the study area may be characterized as predominantly white and non-Hispanic. From 1980 to 1990, the majority of the counties within the study area experienced slight increases in minority levels. Statewide, West Virginia has the lowest proportion of population as minorities. On the other hand, the study area portion of West Virginia shows some of the highest percentage of minorities of all study area counties; five of the study area counties in West Virginia have more than five percent of their population as minority. The highest percentage (13.7 percent) of minorities are located in McDowell County, West Virginia.

Q. ECONOMIC CONDITIONS

1. Recent Trends in Unemployment Rates and Employment

Table III.P-2 includes a comparison of the county unemployment rates to those of the state as of 1998. Only five of the 65 study area counties had a lower unemployment rate than the state in 1998. As for the states, each state total shows consistency with the national trend of declining unemployment from 1990 to 1998. West Virginia's unemployment rate was the highest of the four states in 1990 and 1998. West Virginia's unemployment rate in 1990 was higher than in 1980. In contrast, the other study area states had lower unemployment rates in 1990 than in 1980.

The study area counties nearly all show decreases in unemployment rates from 1990 to 1998, and many of the counties show greater improvements than their state average for the period. On the other hand, many study area counties had increases in unemployment rates for the preceding period (1980-1990), or had slower improvements than the state average. Taken together, the changes for the two periods suggest that the study area counties lagged the states in the 1980's in employment improvements and have begun "catching up" in the 1990's.

Employment totals for 1990 and 1997 reveal increases in employment for all study area states in the 1990's, with Tennessee enjoying the fastest employment growth and West Virginia the slowest growth. For the preceding period (1980-1990), West Virginia saw a slight loss of jobs, while the three other states gained jobs. Many study area counties did not share in the employment growth. However, the study area as a whole gained jobs in the 1990's and all but West Virginia's study area gained jobs in the 1980's. In Kentucky, Tennessee, and Virginia, employment in the study area grew more slowly than in the state in the 1990's. In West Virginia, the study area and the state added jobs at the same rate.

ALL STATES AND EACH STATE'S STUDY AREA GAINED JOBS OVERALL BETWEEN 1990 AND 1997. MANY STUDY AREA COUNTIES, HOWEVER, DID NOT SHARE IN THE EMPLOYMENT GROWTH.

2. The Economic Role of Coal Mining

a. Coal Mining Employment

Table III.Q-1 displays mining employment statistics for the years 1980, 1990, and 1997. For the study area, most mining employment is in coal mining. The statistics reveal a decline in mining employment over both periods, with Kentucky and Tennessee experiencing an accelerating decline. Mining employment losses in West Virginia have actually slowed (but not reversed) over the period 1990-1997 compared to the previous decade. The study area portion of West Virginia saw great declines over the period 1980-1990, losing half its mining jobs. The rate of loss has slowed considerably for the period 1990-1997, and is a slower rate of job loss than the state overall. Nevertheless, in 1980, six of the West Virginia study area counties had more than 4,000 mining employees; in 1997 none of the counties had 4,000 or more employees.

DRAMATIC INCREASES IN MINE PRODUCTIVITY SINCE 1980 HAVE LED TO DRAMATIC DECREASES IN COAL MINING EMPLOYMENT, DESPITE INCREASED COAL PRODUCTION.

An examination of mine employment statistics by researchers at Marshall University's Center for Business and Economic Research (CBER 1999) points to the role of increasing productivity in the declines in West Virginia mining employment. The CBER study noted that coal production increased by 40 % over the period 1980-1998 while underground employment declined by 70% and surface mining employment declined by 50%. The study noted that average underground mining productivity in West Virginia increased from 2,100 tons per employee in 1980 to 8,000 tons per employee in 1998.

Table III.Q-1
Coal Mining Employment[1] by County

Place of Work	1980	1990	1997	Avg Annual Percent Change	
				80-90	90-97
Kentucky	58,117	39,566	26,066	-3.8	-4.1
KY Study	*38,774*	*27,199*	*NA*	*-3.5*	*-4.7*
Bell	2,052	1,383	1,007	-3.9	-3.1
Boyd	185	937	859	17.6	-0.9
Breathitt	1,094	895	137	-2.0	-17.1
Carter	164	197	113	1.9	-5.4
Clay	1,727	222	92	-18.5	-8.4
Elliott	131	L	L	NA	NA
Estill	250	178	110	-3.3	-4.7
Floyd	3,595	2,161	1,034	-5.0	-7.1
Greenup	212	48	D	-13.8	NA
Harlan	4,132	3,456	1,384	-1.8	-8.7
Jackson	37	D	D	NA	NA
Johnson	861	469	249	-5.9	-6.1
Knott	1,105	1,124	1,398	0.2	2.2
Knox	657	325	196	-6.8	-4.9
Laurel	583	367	D	-4.5	NA
Lawrence	116	170	D	3.9	NA
Lee	208	241	99	1.5	-8.5
Leslie	502	1,235	1,199	9.4	-0.3
Letcher	2,517	2,153	1,034	-1.6	-7.1
McCreary	309	10	L	-29.0	NA
Magoffin	572	189	D	-10.5	NA
Martin	3,156	1,488	1,012	-7.2	-3.8
Menifee	22	0	0	-100.0	0.0
Morgan	304	35	24	-19.4	-3.7
Owsley	51	16	D	-10.9	NA
Perry	2,808	2,369	1,203	-1.7	-6.6
Pike	9,954	6,427	5,236	-4.3	-2.0
Powell	57	0	36	-100.0	0.0
Pulaski	262	166	131	-4.5	-2.3
Rockcastle	21	16	D	-2.7	NA
Rowan	0	0	12	0.0	0.0
Wayne	92	14	17	-17.2	2.0
Whitley	1,021	889	230	-1.4	-12.6
Wolfe	17	19	D	1.1	NA

Table III.Q-1
Coal Mining Employment by County
(Continued)

Place of Work	1980	1990	1997	Avg Annual % Change	
				80-90	90-97
Tennessee	11,160	8,859	6,654	-2.3	-2.8
TN Study	*5,144*	*2,704*	*1,308*	*-6.2*	*-7.0*
Anderson	511	266	169	-6.3	-4.4
Bledsoe	L	L	0	NA	NA
Campbell	997	433	353	-8.0	-2.0
Claiborne	684	489	117	-3.3	-13.3
Cumberland	462	352	273	-2.7	-2.5
Fentress	132	87	44	-4.1	-6.6
Grundy	64	64	16	0.0	-12.9
Marion	724	120	85	-16.5	-3.4
Morgan	150	104	52	-3.6	-6.7
Overton	95	78	D	-2.0	NA
Roane	221	123	27	-5.7	-14.1
Scott	1,021	334	58	-10.6	-16.1
Sequatchie	83	254	114	11.8	-7.7
Van Buren	0	0	0	0.0	0.0
Virginia	24,740	18,043	13,331	-3.1	-3.0
VA Study	*20,799*	*12,454*	*8,027*	*-5.0*	*-4.3*
Buchanan	7,920	5,002	2,990	-4.5	-5.0
Dickenson	2,598	1,566	627	-4.9	-8.7
Lee	488	345	483	-3.4	3.4
Russell	1,692	871	630	-6.4	-3.2
Scott	58	22	35	-9.2	4.8
Tazewell	2,646	962	754	-9.6	-2.4
Wise	5,397	3,686	2,508	-3.7	-3.8

Table III.Q-1
Coal Mining Employment by County
(Continued)

Place of Work	1980	1990	1997	Avg Annual 80-90	Avg Annual 90-97
WV	67,617	41,793	28,826	-4.7	-3.6
WV Study	*44,358*	*22,248*	*16,643*	*-6.7*	*-2.9*
Boone	5,813	3,826	3,116	-4.1	-2.0
Braxton	190	480	39	9.7	-22.2
Clay	276	233	D	-1.7	NA
Fayette	1,634	857	625	-6.3	-3.1
Kanawha	6,938	2,614	2,296	-9.3	-1.3
Lincoln	159	275	279	5.6	0.1
Logan	5,092	2,750	1,902	-6.0	-3.6
McDowell	7,601	1,665	908	-14.1	-5.9
Mingo	2,724	3,057	2,713	1.2	-1.2
Nicholas	3,337	1,564	593	-7.3	-9.2
Raleigh	5,117	2,423	1,836	-7.2	-2.7
Wayne	249	318	521	2.5	5.1
Webster	237	364	486	4.4	2.9
Wyoming	4,991	1,822	1,329	-9.6	-3.1

Notes:
[1]Includes surface mining, underground mining and coal mining services.
[2]Study area subtotal includes a small number of jobs not disclosed for one of the counties.

D = estimate not shown to avoid disclosure of confidential information
L = estimate less than 10 jobs
Source: U.S. Bureau of Labor Statistics

Table III.Q-2 displays the economic role of mining as measured by the percentage of total employment and earnings directly attributed to coal mining. The table indicates that, at the state level, mining employment and earnings are not significant in Tennessee and Virginia and are slightly over one percent for Kentucky. Although far from its past prominence, mining continues to play a notable role in West Virginia, accounting for over three percent of that state's total employment and over five percent of total earnings. At the county level, mining can be an extraordinarily prominent economic sector. In 1998, mining made up more than ten percent of employment and personal earnings in a number of the study area counties. The higher proportions for earnings compared to employment reflect the high wages in mining. It should be noted that employment earnings are only a portion of all income in a given county. Other income sources include interest, rent, dividends, pensions, and government transfer payments such as social security.

b. Economic Multiplier Impacts of Coal Mining

The economic role of coal mining is understated by these percentages. Coal mine operators purchase goods and services from other firms and coal miners spend much of their wages on goods and s0ervices sold in their regions and states. These purchases have a multiplier effect on the regional and state economies. The Marshall University Center for Business and Economic Research (CBER) study (Marshall University, 2000) used IMPLAN economic multipliers for West Virginia to examine the impacts of coal mining on the state's economy. According to these multipliers, every direct job in coal mining in 1996 supported two other jobs in the state. In terms of the value of output, every dollar's worth of coal production supported an additional 52 cents in sales in the other sectors of the state economy.

Boone County, West Virginia, is an extreme example of how much one county's economy can depend on coal. Coal mining accounted for approximately one-third of all employment in Boone County in 1998. Marshall University's study estimates that the 30.6 million tons of coal produced in Boone County in 1997 supported 5,032 direct and multiplier jobs, $308.3 million in wages at these jobs, and $985 million in output. These direct and multiplier figures attributed to coal, amount to over half of all jobs, two-thirds of all wages, and over four-fifths of the total value of output for the county.

It is worth repeating that Boone County is a very extreme case of a coal dependent economy. Moreover, the statistics quoted above for Boone County apply to all coal mining, while the majority of mining employment in Boone County is in underground mining. No part of the study area is nearly as dependent on mountaintop mining as Boone County is dependent on coal mining in general.

There are a few ways to express the Boone County impacts in terms of unit impacts. At the rates used in the CBER analysis, every million tons of coal produced in Boone County supported 164 jobs, over $10 million in wages, and over $32 million in total output in the county. Expressed as economic multipliers, every direct coal mining job supported another 0.7 of a job elsewhere in the county. Every dollar of coal output supported another 34 cents in output in other sectors of the county economy. As expected, the multiplier effects for the county are lower than those for the state because businesses and individuals make a smaller proportion of their purchases within the county than they do within the state.

Table III.Q-2
Coal Mining Employment and Earnings Percentages

Location	Mining as Percent of Total	
	1998	
	Employment[1]	Earnings[2]
Kentucky	1.2	1.8
Bell	7.5	D
Boyd	D	D
Breathitt	D	D
Carter	D	D
Clay	D	D
Elliot	D	1.5
Estill	D	D
Floyd	9.3	11.9
Greenup	D	0.8
Harlan	12.6	23.0
Jackson	D	0.0
Johnson	2.9	4.0
Knott	26.6	41.8
Knox	1.9	D
Laurel	D	D
Lawrence	D	D
Lee	3.3	0.3
Leslie	D	D
Letcher	13.1	D
McCreary	D	D
Magoffin	6.4	10.1
Martin	26.5	D
Menifee	D	0.0
Morgan	D	0.2
Owsley	D	D
Perry	7.8	D
Pike	17.0	28.0
Powell	D	0.0
Pulaski	D	D
Rockcastle	D	0.0
Rowan	D	1.2
Wayne	D	0.0
Whitley	1.0	1.4
Wolfe	D	0.0

Table III.Q-2
Coal Mining Employment and Earnings Percentages
(Continued)

Location	Mining as Percent of Total 1998	
	Employment	Earnings
Tennessee	0.2	0.1
Anderson	0.3	0.3
Bledsoe	0.0	0.0
Campbell	1.8	3.2
Claiborne	D	1.4
Cumberland	D	0.7
Fentress	D	0.2
Grundy	D	0.3
Marion	D	D
Morgan	0.8	D
Overton	D	0.0
Roane	D	0.2
Scott	D	D
Sequatchie	2.8	D
Van Buren	D	0.0
Virginia	0.3	0.3
Buchanan	20.5	33.4
Dickenson	14.9	22.5
Lee	4.3	8.5
Norton	D	D
Russell	4.7	9.9
Scott	D	0.9
Tazewell	3.5	5.0
Wise	D	D
West Virginia	3.3	5.4
Boone	33.0	59.7
Braxton	0.7	0.0
Clay	D	D
Fayette	3.8	D
Kanawha	1.7	2.2
Lincoln	6.2	1.9
Logan	12.1	23.5
McDowell	12.6	D
Mingo	24.2	42.1
Nicholas	5.6	17.0
Raleigh	5.0	10.3
Wayne	16.4	8.6
Webster	15.3	31.0
Wyoming	18.4	34.5

D = Information not Disclosed or Less than $50,000 or 10 jobs.
[1]Employment recorded by county of work, not of residence
[2]Earnings data is reported by place of work and includes wage and salary disbursements, other labor income, and proprietor's income. It does not include dividends, interest, rent or transfer payments, which together account for as much as one-half of income in a county.
Source: U.S. Bureau of Economic Analysis, 1997

The economic impact of mining extends beyond the county where the mine is located. It is common among coal miners to commute long distances to jobs. Thus, while the published employment figures indicate where the wages are earned, they do not reflect where they are spent. In addition, the businesses that provide inputs to the coal industry can be located in other counties or states.

c. Mining-Related Tax Revenues

> **COAL PRODUCTION PROVIDES TAX REVENUES TO STATE AND LOCAL GOVERNMENTS DIRECTLY THROUGH SEVERANCE TAXES AND INDIRECTLY THROUGH ROYALTY PAYMENTS ON PUBLIC LANDS, INCOME TAXES, PROPERTY TAXES AND FEDERAL RECLAMATION FUND FEES.**

Coal production provides tax revenues to state and local governments directly through severance taxes and indirectly through royalty payments on public lands, income taxes, property taxes, and federal Reclamation Fund fees. A severance tax is essentially an excise tax imposed on the present and continuing privilege of removing, extracting, severing, or producing a mineral. State and local governments generally levy severance taxes in the form of a percent of the value of the resources removed or sold. Severance tax receipts usually are dependent on energy prices, hydrocarbon production levels, and state and local severance tax rates (EIA 1997). Throughout the study area, coal severance taxes are an important source of revenue for state and local governments and school districts.

Coal production supports abandoned mine land reclamation projects and the United Mine Workers Combined Benefit Fund through the Special Reclamation Fund fee levied under SMCRA Section 402. Surface mined coal is levied a fee at a rate of 35 cents per ton; underground mined coal is levied a fee at a rate of 15 cents per ton. Half of these revenues are supposed to be returned to the state in which the coal was produced, to be used in funding reclamation or acid mine drainage abatement projects at abandoned mines. However, an ongoing controversy over federal congressional management of the AML Fund surrounds the continuing accrual of "excess" funds into the account as collections substantially exceed distributions from the fund. Although the management concerns exist, a significant amount of money does flow to the study area states from the fund. In FY 1999, more than 47 million dollars went to AML programs in the study area states. Kentucky received 22.7 million dollars, West Virginia received 20.2 million dollars, Virginia received 4.4 million dollars, and Tennessee received 0.1 million dollars (OSM Annual Report 1999).

c.1. Kentucky

Kentucky's severance tax rate for coal is 4.5 percent of the gross value of all coal severed and/or processed, with a 50 cent per ton minimum. In 1998, the effective severance tax rate as a percent of the price of coal averaged 4.3 percent. The state collected 186 million dollars in coal severance taxes in that year, accounting for three percent of the general revenue fund and approximately 1.3 percent of total state revenues (Commonwealth of Kentucky, Office of the Controller 1999).

The continued decline in coal prices produced a reduction in receipts received from energy severance taxes. For example, Kentucky collected 203.3 million dollars in fiscal year 1992-93 and 186.1 million dollars in fiscal year 1997-98. Although still an important source of revenue-particularly for local governments–the reliance on coal severance tax receipts has generally declined.

The state established the Local Government Economic Development Fund to provide coal severance tax revenue grants to coal producing counties to assist in the diversification of their local economies. Each coal producing county is allotted a portion of the fund money for use exclusively in that county, and a portion is set aside for multi-county or regional projects. The fund has grown to 82 million dollars in 1997. The percentage of coal severance taxes returned to counties from the fund has increased from 12 percent in 1992 to 31 percent in 1998.

c.2. Virginia

Virginia's local coal and gas road improvement tax and natural gas severance tax are used to provide funds for economic development loans through the Virginia Coalfield Economic Development Authority. According to the Authority's 1998 annual Report, six projects received loans totalling over 3.1 million dollars and six projects received grants totalling 270,000 dollars.

c.3. West Virginia

The major categories of revenue for the West Virginia state government include the General Revenue Fund, the State Road Fund, lottery funds, federal funds and special revenue funds. The General Revenue Fund includes funds from income tax, sales tax, business and occupation taxes and the Natural Resource Severance Tax. The severance tax is levied as a 5 percent privilege tax on the gross receipts on the sale of the product severed. Ninety percent of severance tax revenues come from coal production. Severance tax receipts are allocated to the General Revenue Fund (77 percent), the State Infrastructure Fund (13 percent), local governments (8 percent), and the State Division of Forestry (2 percent). (West Virginia State Budget Office 2000). Based on estimates by the State Budget Office, coal severance taxes contribute roughly five percent of the General Revenue Fund. Recent and projected severance tax receipts are shown in Table III.Q-3.

Approximately 80 percent of severance tax revenues are distributed to local governments. One-fourth of this amount is distributed among municipalities in proportion to population and the remaining three-fourths is reserved for distribution among the coal producing counties in proportion to value of coal production.

Coal mining also contributes to public finance through other taxes, including the various property taxes and income taxes. Property taxes related to active coal mines contributed approximately 43 million dollars statewide in the past fiscal year. Taxes collected on the assessed value of coal reserves contributed another 14 million dollars. Combined, these property taxes accounted for approximately 34 percent of all property taxes collected statewide. Property taxes are a major income source for county governments and school districts in West Virginia. Approximately 68 percent of property tax revenues are allocated to schools and these revenues account for roughly 30 percent of the typical school district budget (Muchow 2000).

Table III.Q-3
West Virginia Severance Tax Receipts, 1997-2003

Fiscal Year	Severance Tax Receipts ($ million)
1997	176.9
1998	175.2
1999	148.4
2000*	161.5
2001*	145
2002*	139.5
2003*	133

* = Projected
Source: West Virginia State Budget Office 2000.

Boone County is an example of a county with a considerable role for coal in its finances. Approximately 4 million dollars in property tax revenue is directly linked to coal production (approximately 10% of its school district budget) and the county received 2.2 million dollars in severance tax distributions in the previous fiscal year (Muchow 2000).

d. The Economic Role of Surface Coal Mining

As labor productivity improved between 1970 and 1997, the number of miners fell by 2.1 percent per year on a national average level and 4.9 percent in the study area. The numbers of miners in surface mining and all coal mining in the study area are displayed in Table III.Q-4 below.

The table illustrates a substantial decrease in the number of miners between 1989 and 1998. In all states and regions shown, the rate of decline in the number of surface miners is less than that of all miners, indicating that the numbers of underground miners have fallen even more notably than the numbers of surface miners. With productivity improvements expected to continue through 2020, the EIA projects a further decline of 1.3 percent a year in the number of miners in the U.S. (EIA, 2000).

Table III.Q-4
Average Number of Coal Miners

Region	1998		1989		Avg. Annual % Change (1989-1998)		Surface Miners as % of Total	
	All Mines	Surface Mines	All Mines	Surface Mines	All Mines	Surface Mines	1998	1989
Eastern Kentucky	14,617	5,164	24,620	8,034	-5.6	-4.8	35%	33%
West Virginia Total	17,167	4,019	29,482	6,434	-5.8	–5.1	23%	22%
So. West Virginia	13,028	3,507	19,202	4,810	-4.2	-3.4	27%	25%
Tennessee	517	244	1,857	386	-13.2	-5.0	47%	21%
Virginia	5,734	1,108	10,371	1,482	-6.4	-3.2	19%	14%
Study Area	38,035	10,535	66,330	16,336	-4.7	-4.0	28%	25%

Source: U.S. Department of Energy, Energy Information Administration. 2000. *Coal Industry Annual 1998.*

The table displays that surface mining employs a minority of the coal miners in the study area. Slightly over one in three eastern Kentucky coal miners in 1998 was a surface miner, while just over one in four miners in southern West Virginia was a surface miner. In 1988, approximately one in five miners in southern West Virginia was a surface miner. The more rapid declines in underground mining employment have increased the share of surface miners in total mining employment for all states and regions shown.

SLIGHTLY OVER ONE IN THREE EASTERN KENTUCKY COAL MINERS IN 1998 WAS A SURFACE MINER, WHILE JUST OVER ONE IN FOUR MINERS IN SOUTHERN WEST VIRGINIA WAS A SURFACE MINER.

Data from the West Virginia Bureau of Employment Programs were used to estimate the proportion of total mining employment in the West Virginia study area counties which corresponds to surface mining. Use of the category “surface mining” is essentially equivalent to “mountaintop mining” for the West Virginia study area counties. Surface mining employment data were not identified for the counties in the other study area states and were not available for all study area counties in West Virginia.

According to the West Virginia Bureau of Employment Programs, approximately 23 percent of bituminous coal mining employment in Boone County was engaged in surface mining in 1998 and 37.5 percent of all employment in the County was in coal mining, including coal mining services. Combining these percentages yields the statistic that 8.6 percent of Boone County employment in 1998 was directly related surface mining. Surface mining proportions for the other West Virginia counties with available data are shown in Table III.Q-5

The data in Table III.Q-5 indicate that, as measured by percent of workers, surface mining is particularly important in the economies of Boone, Logan, and Mingo counties. Although not shown directly in the table, underground mining is a major source of employment in Boone, McDowell, Mingo, and Wyoming counties.

Table III.Q-5
West Virginia Surface Mining Employment, 1998

	All Coal Mining	Surface Mining Employment	
County	% of All Employment	Percent of Bituminous Mining Employment	Percent of Total County Employment
Boone	37.5	22.8	8.6
Fayette	4.6	61.2	2.8
Kanawha	1.1	53.2	0.6
Logan	13.2	58.6	7.6
McDowell	15.7	12.3	1.9
Mingo	29.1	37.7	11.0
Nicholas	7.1	30.0	2.1
Raleigh	5.9	7.8	0.5
Wyoming	21.9	1.4	0.3

Source: West Virginia Bureau of Employment Programs, 1999

3. Economic Projections

a. Central Appalachia Baseline Coal Economy Projections from EIA and University of Kentucky

The year 2001 Energy Information Administration (EIA) baseline scenario forecast for central Appalachia (the coal production region that encompasses the study area exclusive of Tennessee) projects a modest (4.8 percent) decline in coal production, combined with a considerable (14.2 percent) fall in prices over the period 1997 to 2010. The two decreases combine for an 18.3 percent decrease in coal sales and a projected loss of 7,700 coal mining jobs (Univ. of Kentucky Center for Business and Economic Research 2000, p.115).

This direct employment loss is estimated as corresponding to a 2.4 percent decline in employment in the central Appalachian region. The associated earnings loss is estimated as accounting for a 3.4 percent decline in earnings in the region (Univ. of Kentucky Center for Business and Economic Research 2000, p.117). The University of Kentucky study applied economic multipliers to the direct employment changes to estimate a 6.5 percent decrease in all jobs (directly and indirectly related to coal mining) and a 6.1 percent decrease in total earnings (Univ. of Kentucky Center for Business and Economic Research 2000, p.120).

b. Marshall University Study for the West Virginia Senate Finance Committee

A study commissioned by the West Virginia Senate Finance Committee and conducted by Marshall University's Center for Business and Economic Research found a similar result for a nine-county study area in southern West Virginia. The Marshall University study examined economic impacts of three different coal production scenarios for a one-year period (2000). Their baseline forecast projects a one percent decline (1,646) in total private sector employment resulting from an approximately seven percent decline in coal production. Their county-by-county analysis projected greatly varying results among counties, with some projected to actually gain employment, and others to lose as much as 7.8 percent of total employment as a result of a decrease in mining jobs and associated multiplier jobs (Marshall University CBER 2000).

The Marshall University study and the University of Kentucky study reported above focus on the coal-mining economic impacts. The losses projected in these studies are the jobs and earnings that would be subtracted from these economies due to coal mining losses. These studies do not project actual total employment and earnings changes, net of other economic changes. Indeed, there are other economic forces at work that are projected to bring new economic base jobs and associated multiplier employment. The direct and multiplier losses reported in these studies indicate the extent to which the mining losses place a drag on the subject economies. That is, they measure (very roughly) how many more jobs the economy would have gained, had the mining jobs not been lost. The West Virginia statewide economic outlook described below illustrates a projection of a net overall positive change in the statewide economy, despite considerable losses in coal mining.

c. Statewide Overall Economic Forecasts

A 10-year forecast in the West Virginia Economic Outlook (WVU BBER 2000) calls for a continuation of the recent trend of slower growth in the state. The forecast calls for West Virginians to be better off (in terms of real per capita personal income) in 2010 than they are now. The forecast also suggests that state growth will fall short of that expected for the nation. This slowed relative growth implies a widening per capita personal income gap with the nation in coming years.

The long-term outlook for job growth calls for modest annual gains through 2010, with state job growth falling well short of national growth. All net job gains are expected to come in the service-producing sectors, with goods-producing jobs continuing their downward slide. Mining jobs (especially coal mining) are expected to drop at a swift pace. (WVU BBER 2000)

Job growth in construction is expected to be slower during the next 10 years than it was during the 1990s. The outlook also calls for manufacturing jobs to decline, although at a slower pace than during the previous 10-year period. This slowdown in manufacturing job losses is primarily due to job gains in durable manufacturing (especially lumber and wood products and transportation equipment). Nondurable manufacturing jobs decline during the forecast, as job losses in chemical products and apparel overwhelm gains in printing and publishing and food products. (WVU BBER 2000)

A large factor in the overall job growth slowdown during the forecast is the deceleration in job growth in services. This sector is expected to remain the fastest growing industry in the state (in terms of generating jobs), but that growth is likely to be slower than it has been. The slowdown is expected to permeate all services sectors, including business services, health care services, social services, and membership organizations. The forecast calls for business services (which has produced very strong job gains this decade) to continue to lead the pack in services job growth during the next 10 years. Further, travel-related services are likely to continue to grow in the state. (WVU BBER 2000)

The forecast calls for the state's population to register moderate losses during the forecast, as slow job and income growth are insufficient to stem outmigration. Finally, the forecast calls for the unemployment rate to stabilize in the 5.5-6.0 percent range. (WVU BBER 2000)

R. LAND USE AND POTENTIAL DEVELOPMENT

1. Historical and Current Land Uses

The two most important features of the study area in determining land uses are the natural landscape and the ownership of rights to the potentially mineable coal beneath the land surface. The steep slopes and the narrow, flood prone river valleys severely constrain the available supply of developable land. Most of the land is in forest cover and human occupation is generally concentrated in stream valleys.

a. Current Land Uses, Study Area Overall

The overwhelming land use in the study area is forest which covers approximately 11 million acres or 92 percent of the approximate 12 million acre study area. Deciduous forests cover over 9 million acres or 79 percent of the study area. Mixed deciduous and evergreen forest comprise 9 percent of the study area. Developed areas (residential, commercial and industrial) account for about 1 percent of the study area.

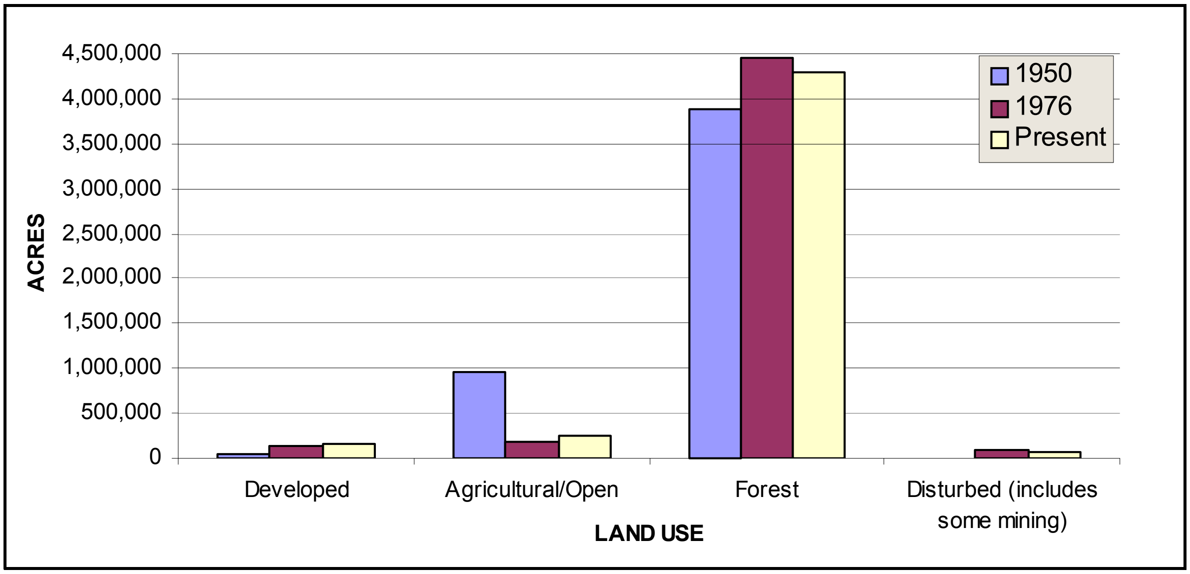
b. Current Land Uses, West Virginia Study Area

The *West Virginia University Land Use Assessment* (2002) was conducted to examine land use issues associated with mountaintop mining in the 14 county study region of southern West Virginia. The results were derived from a classification of recent Landsat satellite data. The satellite data were classified and converted to a GIS (geographic information system) coverage for analysis and display. Results confirm the forested/lightly developed character of the West Virginia mountaintop mining region. Almost 88%, or slightly over four million acres, was classified as mature forest land with the diverse mesophytic forest type being most prevalent at almost three million acres of area. All developed land uses (intensive urban, moderately intensive urban, light urban, populated areas, major roads, and infrastructure such as power lines) accounted for 155,000 acres or roughly three percent of the land area. Agricultural land uses were found on approximately a quarter of a million acres or five percent of the land area. Other general land use/land cover categories include: shrub land and woodland areas with slightly over 63,000 acres; water/wetlands with 56,000 acres or one percent of the land area; and barren land – mining being 74,000 acres or 1.5% of the study area.

c. Patterns of Land Use Changes, West Virginia Study Area

Figure III.R-1 presents general land use/land cover changes for the 14 county West Virginia study area examining three different time periods – 1950, 1976, and 2001 ("current conditions"). Data for 1950 were obtained from detailed paper maps that were compiled during a four-year land cover-mapping project that was completed by the U.S. Forest Service for West Virginia. The 1976 data source is the USGS GIRAS land use data that were digitized by USGS from 1976 vintage 1:48,000 scale aerial photography. The current data are from the results of the WVU – NRAC satellite data classification effort.

Figure III.R-1
Land Use Characteristics for the West Virginia Study Area



Source: WVU 2002, *West Virginia Land Use Assessment*

An analysis of the data from these three periods reveals the following general patterns of land use change in the region:

- The acreage of developed area increased from 42,533 acres in 1950 to 154,966 acres currently. This acreage probably does not include much of the dispersed development that dominates the region.
- Agricultural acreage *decreased* from almost a million acres in 1950 to 188,000 acres in 1976 and then *increased* to 246,000 acres by 2001. Much of the acreage increase in this second period is due to coal mining and reclamation that converted areas from existing forest land to grassland/pasture.
- Forest areas increased from under four million acres in 1950 to almost 4.5 million acres in 1976 and then fell to under 4.3 million acres by 2001. The current loss of forest land is due to patterns in mine reclamation converted land from forest to open–grassland/pasture and to new urban development in the region.
- Disturbed areas increased from just over 3,000 acres in 1950 to a high of 85,000 acres in 1976 and over 73,000 acres currently. This acreage are areas that were not vegetated in those time periods. Lands that are not vegetated and otherwise fit in no other categories are classified as "disturbed". Revegetated mined lands would not fall under this category.

A separate estimation of the extent of mining was developed by WVU for the land use study because other sources generally significantly underestimate mined areas by placing reclaimed areas into other land use/land cover categories such as grassland/pasture and forest. A compilation of various data sources indicate that over 244,000 acres or approximately 5% of the West Virginia mountaintop mining study area contains evidence as having been disturbed by past or current mining. Mining related land uses are the second most prevalent land use/land cover in the region – after forest land.

This total includes a number of different mine types – unreclaimed abandoned mines, unreclaimed mines with forfeited bonds, reclaimed mines (where the resulting post-reclamation land use allowed for identification and delineation), and active mines. Again it is probable that significant mined areas were undetected by the various data sources, as well as subsequent checking and verification. Also, this estimate does not include areas that have been fully reclaimed or converted to a post-mining land use or off-site impact areas such as clogged stream channels.

2. The Role of Land and Mineral Ownership

In many coal producing areas, the surface and subsurface ownership rights are held by different parties. This separation became a source of conflict with the growth of surface mining because the removal of the mineral entails destruction of surface uses and structures. SMCRA requires the permission of the surface owner or explicit rights by deed or contract as a prerequisite to processing a permit application.

Because the economics of coal production favor large scale operations, it is common for coal mining interests to control potentially mineable land in large blocks. These owners may be land companies that own the land for the purpose of collecting royalty payments from coal mining companies, coal mining companies themselves, diversified fuel conglomerates, electric utilities, or others. When the potential value of the underlying coal is greater than the return from surface development of the land, mineral owners have an incentive to prevent land development (Miller 1974).

Concentration of mineral ownership and associated limitations to the availability of developable land occur in the study area. For example, a study in West Virginia in 1974 found that 23 owners owned 91 percent of surface acreage in Boone County, 17 owners controlled 59 percent of Fayette County, and six major landowners owned 23 percent of the acreage in Kanawha County (Miller, 1974). The Mountain Association for Community Economic Development (MACED) examined private mineral ownership maps and deeds for Letcher County, Kentucky in 1998. MACED found that eighteen owners (sixteen corporations and two private individuals) owned mineral rights in at least 65 percent of the county's land mass of 217,000 acres (MACED 1999). The 65 percent is a minimum because information on parts of the county was not available to MACED. Few of the owners were located regionally. Several of the top owners were based outside of the Appalachian region.

3. Land Use and Economic Development Planning

The region's economic dependence on its exhaustible coal resources, its need to diversify, and its need to further develop the human resources and infrastructure to support economic development are widely recognized. Most leaders are also keenly aware that its coal resources are its best source of leverage for investments needed to build an economy that can continue to flourish after the inevitable decline of coal mining. The collection and distribution of coal related taxes was described in section III.Q. This subsection describes the institutional framework for economic development planning and promotion.

There are a number of agencies at the regional level which address planning and development issues within the study area. Regional agencies include those created at the federal level, such as the Appalachian Regional Commission (ARC) and those created at the state level such as Kentucky's Office of Coal County Development. The following is a brief overview of these agencies.

a. Appalachian Regional Commission (ARC)

ARC was established by Congress in 1965 to support economic and social development in the Appalachian Region. ARC undertakes projects that address five goals: 1) developing a knowledgeable and skilled population; 2) strengthening the region's physical infrastructure; 3) building local and regional capacity; 4) creating a dynamic economic base; and 5) fostering healthy people.

To meet these goals, ARC helps fund such projects as education and workforce training programs, highway construction, water and sewer system construction, leadership development programs, small business startups and expansions, and the development of health care resources. ARC's area development funding functions include the Distressed Counties Program, which provides special funding for the region's poorest counties. Forty-seven of the study area's 69 counties are designated as "distressed counties" for fiscal year 1999.

ARC works with the states to support a network of multi-county planning and development organizations, or local development districts (LDDs). The LDDs most important role is to identify priority needs of their local communities.

b. Kentucky

In 1997, the state of Kentucky created the Office of Coal County Development to assist coal producing counties in diversifying their economies beyond coal. The Office of Coal County Development is charged with overseeing the Local Government Economic Development Fund (LGEDF). This fund, described briefly in section III.Q, distributes coal severance tax revenues. The principle economic development planning functions in eastern Kentucky are carried out by the Area Development Districts (ADD).

c. Virginia

The Virginia Area Development Act authorized the establishment of twenty-one planning district commissions in the state. Of the twenty-one, two serve the seven counties and one city within the Virginia coalfield area. Examples of planning district commisstion projects range from recreation programs to zoning and comprehensive planning assistance.

d. West Virginia

The land use planning function in West Virginia, when it is carried out at all, has usually been carried out by ad hoc boards and commissions, which are not integrated into local policy development or decision making. Planning has not been internalized as a central policy or program concern of local government. A number of counties have no planning commission and, of those that do, some have no staff and no effective power. Only some of the counties have adopted comprehensive plans, zoning ordinances, or subdivision/land development ordinances. There is a consensus for local planning in the three more heavily developed counties in the region – Fayette, Kanawha, and Raleigh Counties, but not in a majority of the region. Within the counties, there are several incorporated municipalities that have adopted various levels of planning functions and controls.

At the state level, the West Virginia Development Office has a number of functions relating to economic development in the study area. The Community Development Division administers a variety of state and federal programs to help develop human resources and install public utilities, access roads, buildings, streets, sidewalks and other public improvements.

Enrolled Senate Bill 681 of 1999 established the Office of Coalfield Community Development within the West Virginia Development Office. Among other duties, the office is responsible for overseeing the preparation of community impact statements by coal operators and for coordinating the preparation of coal field community development statements.

Local communities (even those with active planning) do not really have much direct control over post-mining land use planning and reclamation. However, post-mining land use compatibility with community zoning or subdivision ordinances may be evaluated by the SMCRA regulatory authorities. Local planning and ordinances may be considered during WVDEP's review of the mining permit and proposed post-mining land use plans (WVU Land Use Assessment 2001).

4. Land Use Needs and Development Potentials

a. Intensive Human Use

Two of the factors most often cited as hindering economic development in Central Appalachia are the rugged terrain and the poor access. The Appalachian Regional Commission has been attacking the access limitations since its inception in the 1960s, with an aggressive highway funding program. Access to much of the study area has improved over the years, although not all counties are readily accessible. The steep slopes and narrow, flood prone valleys have limited the availability of land parcels suitable for large scale development. The provision of large parcels of flat to gently sloped terrain is therefore sometimes cited as a positive potential side effect of mountaintop removal and steep slope AOC variance reclamation. The usefulness of such flattened land is dependent on the presence of other factors supportive of development, such as infrastructure and excess market demand for developable land.

THE STEEP SLOPES AND NARROW, FLOOD PRONE VALLEYS HAVE LIMITED THE AVAILABILITY OF LAND PARCELS SUITABLE FOR LARGE SCALE DEVELOPMENT.

An analysis of West Virginia region-wide land development potentials, limitations, and demands was completed as part of the WVU Land Use Assessment study using the Clarke Urban Growth Model (WVU Land Use Assessment 2001). The results indicate that over 1.3 million acres or 28% of the land in the region were placed into the highest category that was judged to be land with some opportunity for development – though some development restrictions might be present (e.g. unstable soils). An additional 20% of the region was placed into a moderate development potentials category indicating development potential with potentially significant development restrictions (e.g. flood potentials). The remaining three classes: limited, severely limited, and highly restricted, represent areas where development restrictions generally far outweigh the development opportunities that are present. Almost 50% of the region has limited development potentials due to the presence of what are often multiple severe development restrictions.

These results indicate that though much of the undeveloped land in the region has limited development potentials, there is a significant supply of undeveloped but developable land. However, these lands are not evenly distibuted among the counties, and moderate development restrictions may need to be addressed in developing most of these areas (e.g. flood protection or special methods for steep slope conditions).

b. Recreation

Public land needs and demands are very heavily tied to recreation development in the region. There are certainly localized demands for public lands for uses such as schools, community parks, and other public facility developments (WV State Comprehensive Outdoor Recreation Plan 1997). However, the acreage requirements for most of this development are minimal, and will be linked to existing community locations in most cases. A compilation of the major demands for public lands in the region identified by various federal and state agencies shows significant differences between counties in the region in the need/demand for hunting and fishing, water recreation, and special needs recreation areas – facilities that generally require significant areas. Counties that have a high demand/need for one or more of these activity areas are Kanawha, Lincoln, Logan, Raleigh and Wayne Counties (WVDNR Capital Improvements Plan 1998) (WVU Land Use Assessment 2001).

c. Commercial Forestry

The wood products industry in West Virginia has been a growing economic force in the state. However, a Division of Forestry inventory indicates that industry growth could become constrained by timber supply limitations. An increase in the lands in commercial forestry would help to continue to feed the growth of the study area's wood products industry.

d. Future Land Use Needs

Future land use development needs are difficult to estimate for the West Virginia study region because it is anticipated that the majority of the region will continue to lose population or current population levels will remain static. Population projections for current conditions to 2010, estimate that only Raleigh County will have a significant demand for new land use development based on anticipated population growth. This demand is estimated to range between 1,483 and 3,954 acres of required new development for the ten-year time period. Kanawha County is also expected to require new land for urban expansion. However, much of this area is actually due to shifting development patterns rather than new growth. Projections indicate between sixteen and thirty new square kilometers of new urban land uses will be potentially developed in Kanawha County between 2000 and 2010. The other counties in the study area will require insignificant acreage for the new development that is anticipated during the ten year 2000 to 2010 time period (WVU Land Use Assessment 2001).

S. HISTORIC AND ARCHAEOLOGICAL RESOURCES

Historic and archaeological resources are sometimes broadly categorized as "cultural resources." Cultural resources consist of prehistoric and historic districts, sites, structures, artifacts, and other physical evidence of human activities considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Prehistoric and historic archaeological resources are locations where human activity measurably altered the earth or left deposits of physical remains. Typical environments in which archaeological resources can be found include rock shelters, terraces, floodplains, Native American burial mounds, and ridgetops. Architectural resources, which may include dams, bridges, and other structures having historic or aesthetic importance, generally must be older than 50 years to be considered for protection under existing federal cultural resource laws.

Cultural resources that may be present within mine sites include cemeteries, historical sites and structures, archeological sites, public parks, and other features of cultural significance to surrounding communities. Historical cemetery sites may exist in coal mining areas because they were often located on mountaintops and ridge crests. SMCRA prohibits mining within 100 feet of a cemetery, although cemeteries may be relocated if authorized by applicable state laws or regulations. Mining may not be conducted in public parks or places listed in the National Register of Historic Places without joint approval of federal, state, and local agencies with jurisdiction over these features. Consultation under Section 106 of the National Historic Preservation Act compels agencies to consider the impact of mining projects on historic properties and the various alternatives to minimizing adverse effects. Permit applicants may be required to conduct archeological surveys of proposed mine sites if the reviewing agencies believe that archeological sites may be present. Mining is not allowed in the National Park System, the National Wildlife Refuge System, the National System of Trails, the National Wilderness Preservation System, the Wild and Scenic Rivers System, or National Recreation Areas unless valid existing rights can be demonstrated under the guidelines established in 30 CFR 761.16.

Areas of community concern but not otherwise designated for regulatory protection may also become a consideration during the permitting process. An example of this would be the recent controversy over proposed plans to mine on Blair Mountain in West Virginia, site of a bloody conflict between coal operators and miners attempting to unionize in 1921.

Lists of known recorded cultural resource sites for the study area are maintained by the Kentucky, Tennessee, and West Virginia State Historic Preservation Offices, and the Virginia Department of Historic Resources. In addition, the National Park Service maintains an online version of the National Register Information System (NRIS) [http://www.nr.nps.gov/nrishome.htm].

The first evidence of human habitation in the Appalachians relates to the Paleo-Indians period, perhaps as far back as 13,000 B.C. Such sites have been investigated in Pennsylvania and Virginia. Gardner has investigated the earliest known structure in the New World at the Thunderbird site in Virginia (1974) and has associated it with a Paleo-Indian occupation (Cunningham, 1973). A nearby butchering station also has been associated with a Paleo-Indian occupation. Both sites date to about 11,000 B.C.

Typical artifact assemblages found at known Paleo-Indian sites include: fluted, lanceolate projectile points; uniface, blade-like, snub-nosed scrapers; uniface side blades; gravers; and other blade and flake tools. Evidence from known occupation sites indicated that individual sites were occupied temporarily or seasonally over a long period of time.

Paleo-Indian occupation sites have been found on sandy alluvial hillocks at elevations of about 100 feet above major river valleys as well as on upland flats. Ridge tops, being presumed routes of travel for people as well as game, have potential for Paleo-Indian sites. Saline springs and salt licks on terraces attracted large herbivores, serving to draw in the big game hunting Paleo-Indians. Salt licks have been associated with coal formations (Cunningham 1973).

Remains of Archaic cultural groups have been found in the Appalachians. Projectile points, chipped flint hoes, flint scrapers, drills, and fragments of faceted hematite have been recovered.

The later Archaic sites contained evidence of increasing dependence on grain and vegetables as food sources. Pigweed and goosefoot may have been cultivated. Bowls of the mineral steatite were made prior to the introduction of vessels made of clay. Grave offerings and red ochre often accompany burials.

Late Adena sites contained evidence of cultural influences from groups to the north and west, known as Hopewell cultural groups. Mounds covered log tombs in which one or more burials had been placed, and many tombs were destroyed during the later construction of a mound. Grave goods included ornamental offerings such as effigy pipes, pendants, gorgets, copper bracelets and rings, and grooved stone tablets. Late Adena houses were of double post side wall construction.

In the period between 900 and 1700 A.D., the Fort Ancient people lived in large, compact villages surrounded by stockades, with rows of rectangular houses. The villagers farmed corn, beans, and squash. Burials were no longer made in mounds. The dead were placed in pits inside the villages or inside house walls. Artifacts included small, triangular projectile points, drills, scrapers, blades, hoes, celts, awls, fish hooks, bird bone flutes, shell beads, ear plugs, and pottery vessels and pipes. Some late Fort Ancient sites contained European trade goods.

Settlers arrived in Appalachia during the 1700s. Cultural resources related to first permanent settlements, pioneer settlers, Revolutionary War forts, Civil War battles, and Civil War hospitals have been identified in the study area and are recorded by the state historic preservation offices.

T. ECONOMIC IMPORTANCE OF EXISTING LANDSCAPE AND ENVIRONMENTAL QUALITY

The natural environment is the key defining feature of the study area. The rugged terrain, the vast mixed hardwood forests, the narrow river valleys and the extensive coalfields have profoundly shaped the culture, economy, and quality of life of the region's residents. The land provides the livelihood, and forms the basis for a way of life for much of the population. This section provides an overview of some of the ways in which the landscape and quality of the natural environment play a role in the economy and quality of life in the study area.

1. Outdoor Recreation and Tourism

The tourism and travel industry represents a major component of the study area's economy. As an industry, tourism encompasses a variety of the other employment and industrial sectors, such as wholesale and retail trade, services, amusement and recreation. Tourism and travel businesses directly include: public and private campgrounds; hotels; motels; restaurants; gift shops; service stations; amusements; and other recreation facilities. Tourism is an export industry in the sense that it brings outside money into the regional economy. Also, tourism spending by the region's residents benefits the regional economy compared to the alternative of residents traveling elsewhere for recreation. The tourism industry produces an indirect positive effect on all economic sectors of the study area.

Resident and non-resident tourists travel to various outdoor recreational sites throughout the study area for camping, hiking, fishing, swimming, canoeing, hunting, boating, and sight seeing. In addition, tourists are also drawn to the many visual, cultural, and natural amenities found throughout the study area. For example, within the study area in West Virginia alone there are approximately 15 state parks and forests, in addition to 10 designated wildlife management areas for hunting and fishing.

RESIDENT AND NON-RESIDENT TOURISTS TRAVEL TO VARIOUS OUTDOOR RECREATIONAL SITES THROUGHOUT THE STUDY AREA FOR CAMPING, HIKING, FISHING, SWIMMING, CANOEING, HUNTING, BOATING, AND SIGHT SEEING.

There is a positive correlation between environmental quality and tourism growth. Most national and international tourism experts believe that a clean and healthy natural environment is an essential ingredient for tourism growth in both urban and rural areas (World Travel and Tourism Council 2000).

Tourism revenue information was not available by county or as a subgroup of any state; therefore, the specific significance of tourism to the study area cannot be put in numeric terms. The importance of outdoor oriented tourism to each individual state is discussed below.

a. Kentucky

According to Kentucky's 1995 Outdoor Recreation Plan, "...tourism is one of Kentucky's top industries: the third largest revenue producer, and the second largest private employer (Commonwealth of Kentucky, 1985). The Kentucky Tourism Development Cabinet reported that tourism and travel contributed 7.4 billion dollars to the state's economy in 1997, and is the state's second largest private employer, providing 146,738 full time, year round jobs. According to the Kentucky Department of Travel, visitations to Kentucky's state parks increased slightly from 8.66 million in 1996 to 8.72 million in 1998 (Department of Travel, 1999).

The Kentucky portion of the study area is located in the tourism region that the Kentucky Department of Tourism names the "Eastern Highlands." Tourism and recreational activities in the this area relate to the scenic beauty of the Appalachian Mountains. A significant attraction is the Daniel Boone National Forest, which includes the Red River Gorge. The Red River Gorge is a unique landscape containing unusual flora, which is surrounded by more than 80 natural arches sculpted by wind and water for 70 million years. The Red River is Kentucky's only National Wild and Scenic River. Another significant attraction in the Eastern Highlands is the Cumberland Gap National Historic Park. This 20,305 acres area of wilderness is the largest National Historic Park in the country.

The 1997 state average for foodservices and accommodations sales per capita (in thousands) was 1.04. Boyd, Perry and Rowan Counties had higher sales per capita than the state average (1.38, 1.11, and 1.09, respectively). Laurel and Whitley counties were just below the state average (1.02 and 0.98, respectively). This suggests that these five study area counties may be tourism destinations. The five counties mentioned all contain major transportation corridors and/or tourist attractions. Rowan County contains Cave Run Lake, a popular tourist destination, as well as the Red River Gorge. Morehead State College is also located in Rowan County, and I-64 bisects the county. The Daniel Boone Parkway terminates on I-80 in Perry County. The city of Hazard is also located in Perry County.

Whitley County is located along the Kentucky-Tennessee border, and Laurel County is located just north of Whitley. I-75 bisects Laurel and Whitley counties, and the Daniel Boone Parkway terminates on I-75 in Laurel County. The Laurel and Whitley county area also contains the Daniel Boone National Forest and Cumberland Lake.

Boyd County, located along the Kentucky-West Virginia and Kentucky-Ohio borders, contains a section of I-64. However, the oil refinery industry located in Boyd may also be responsible for the higher than average accommodations and foodservices sales in the county.

b. Tennessee

According to the Tennessee Department of Tourism Development (Department of Tourism Development, 1999), "Tennessee's 8.5 billion dollars tourism industry, drawing almost 40 million visitors in 1997, is a major economic factor for a majority of Tennessee's 95 counties." The importance of Tennessee's outdoor recreation facilities, and their relationship to the state's tourism industry is exemplified in the 1995 Tennessee State Recreation Plan: "Parks and recreation programs and facilities are vitally important to local economies. Leisure programs provide an economic stimulus that in some communities is the driving economic force and the anchor of the tourism industry"(State of Tennessee, 1995). Some of Tennessee's most valuable outdoor recreation areas are located in the study area, particularly on the coal bearing Cumberland Plateau. Fall Creek Falls State Resort Park, which is partially located in the west central portion of Bledsoe County, "is one of the most scenic and spectacular outdoor recreation areas in America" (Department of Environment and Conservation, 1999).

The 1997 state average for foodservices and accommodations sales per capita (in thousands) was 1.26. All the study area counties were below the state average. Cumberland County was the closest to the state average with sales per capita of 0.92. Route 40, which connects the major cities of Nashville and Knoxville, runs through Cumberland County. Cumberland County's higher sales in comparison to the other counties may be related its location. The other study area counties do not appear to be tourism destinations.

c. Virginia

Tourism is one of Virginia's largest industries and is the third largest retail industry Virginia Department of Conservation and Recreation,(Virginia Tourism Corporation, 1999). Park visitation has a profound effect on the state and local economies. According to the 1996 Virginia Outdoors Plan, day use park visitors spend approximately 16 dollars per day, which amounts to a 68 million dollars contribution annually to Virginia's economy (Virginia Department of Conservation and Recreation, 1996)." The number of annual visitations to Virginia's state parks has risen in recent years.

As stated in the 1996 plan, outdoor recreational activities are vital to Virginia's rural economies: "Outdoor recreation also offers much in the way of supplemental income and small-business opportunities to entrepreneurial residents of rural communities, including: land-leasing for hunting, hunting preserves and hunt clubs, fee-fishing…. Economic development and tourism officials in rural Virginia are increasingly aware of the economic potential associated with promoting outdoor recreational opportunities and related services."

A popular tourist attraction located in the study area is the Blue Ridge Parkway. The parkway, which is one of the nation's premiere scenic roads, is being impacted by the effects of urban development. Overlooks that once provided scenic views of forests and rolling agricultural land are now revealing factories and residential developments. As emphasized in the 1996 plan, "This increasing encroachment will impact the quality of visitors' recreational experiences."

In 1997, all of the study area counties had significantly lower sales per capita in comparison to the state average for accommodations and foodservices. This suggests that none of the study area counties are tourism destinations.

d. West Virginia

The Bureau of Business Research at West Virginia University estimated the total economic impact of travel and tourism in West Virginia at 2.54 billion dollars in 1991. Employment and payroll were estimated at 49,665 persons and 535 million dollars, with another 116 million dollars in state tax revenues (West Virginia University, 2000). The economic impact of outdoor recreation activities is gaining increased recognition among West Virginia's state and local officials. Tourism, in particular, has been identified as one of the state's target industries in its strategic plan for economic development (WVSCORP, p. 38).

In 1999 the West Virginia Division of Tourism studied the impacts of "domestic leisure visitation" on the state for a five year period from 1993 to1998. The results of that study indicate that the number of visitors and length of their stays have increased overall from 1993 to 1998. The increase in length of stay from 1993 to 1998 was 7.1 million days, and the total visitors to the state increased by 2.3 million people (Department of Tourism, 1989). This study also indicates a 21% increase in direct revenues from tourism spending between 1997 and 1998, a significant increase which is reflects of the growing importance tourism has on the economy.

West Virginia's tourism industry is highly dependent upon its natural resources and scenic beauty. According to the state's 1993 Statewide Comprehensive Outdoor Recreation Plan (SCORP), the most popular activity among non-resident visitors is sightseeing, followed by visiting national and state parks, attending fairs and festivals, visiting cultural sites, hiking, rafting, camping, hunting/fishing, golf, and skiing (State of West Virginia, 1983).

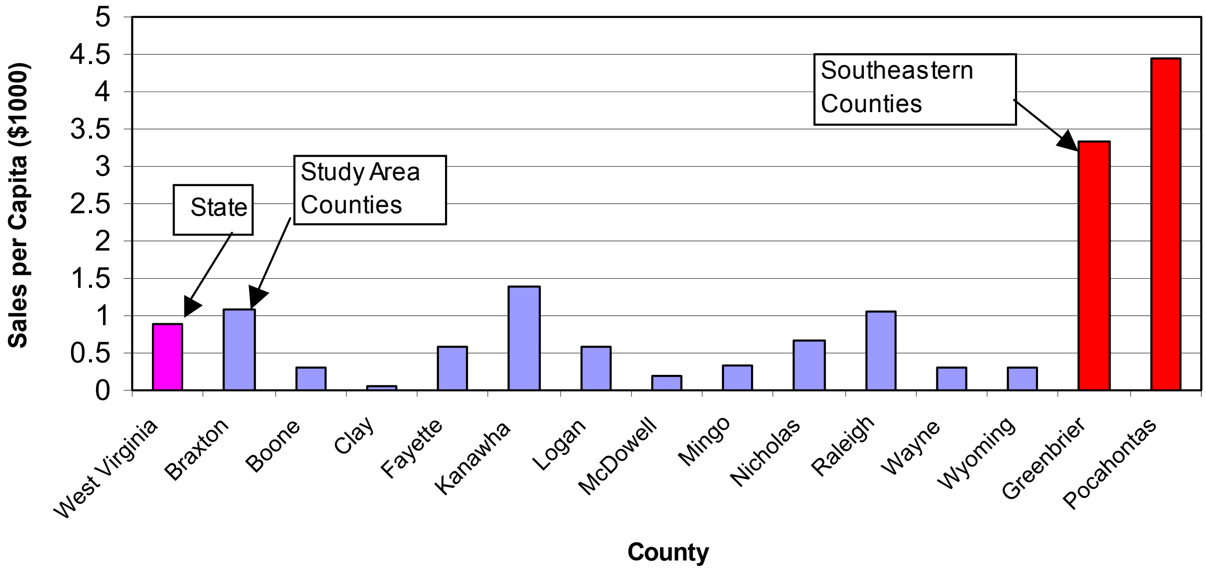
Outdoor recreation activities are closely entwined with natural resource preservation. A very large proportion of the study area's outdoor recreation experiences are highly dependent upon the quality of the natural environment. To quote promotional materials used by the Southern West Virginia Convention and Visitors' Bureau (1999), "The mountains, as we refer to them, of southern West Virginia call out to your inner soul. Their rivers offer the best whitewater rafting east of the Colorado and scenic hiking, biking and rock climbing trails abound". Development activities threaten this valued environment through effects such as diminished scenic viewsheds and degraded water quality.

Within the study area in West Virginia there are approximately 15 state parks and forests, in addition to 10 designated wildlife management areas for hunting and fishing. Whitewater rafting, hunting, and fishing are drawing increasing numbers of tourists to southern West Virginia. These activities can only take place in the proper setting, thus further emphasizing the importance of maintaining these settings to draw tourists to the area. About 250,000 whitewater rafting enthusiasts raft West Virginia waters each year. In southern West Virginia the New River is an important rafting resource, named by the AAA Mid-Atlantic Tour Book as a world renowned whitewater rafting location.

In 1998 hunting and fishing generated over 15.5 million dollars in license sales, and of those licenses about 308,000, or roughly 27 percent were sold to non-residents (Department of Tourism, 1989). Based on West Virginia Division of Wildlife Data, the study area portion of the state is not the highest revenue generating area for hunting and fishing license sales, however, the location of sale is not necessarily the location of the hunting and fishing activity.

In general, the study area counties have much lower sales per capita in the foodservices and accommodations sector than the two southeastern counties of Greenbriar and Pocahontas, and the state as a whole, suggesting that the study area is not a major tourism destination. West Virginia has an average sales per capita of 900 dollars in the food services and accommodations sector. The average sales per capita for the study area counties is 620 dollars (U.S. Bureau of the Census, 1997). In contrast, Greenbriar and Pocahontas counties had sales per capita of 3,340 and 4,440 dollars, respectively.

Figure III.T-1
West Virginia Food Services and Accommodations Sales Per Capita, 1997



Two study area counties, Kanawha County and Fayette County, have somewhat higher sales per capita in foodservices and accommodations. Kanawha has sales per capita of 1,380 dollars and Fayette has sales per capita of 1,740 dollars (U.S. Bureau of the Census, 1997) [see Figure III.T-1]. The higher sales in these counties may be due to several factors. Kanawha County contains the city of Charleston, the state capitol of West Virginia. Interstate 64, Interstate 79, and Route 77, the West Virginia Turnpike, and the Kanawha River, a tourist destination, all run through the county as well. Fayette County also contains a section of the West Virginia Turnpike, as well as Amtrak. The New River Gorge National River is primarily located in Fayette County as well.

2. Non-traditional Forest Products

POPULATIONS IN THE APPALACHIA REGION RELY UPON THE NATURAL ENVIRONMENT FOR A RANGE OF ACTIVITIES INCLUDING THE HARVESTING OF NON-TRADITIONAL FOREST PRODUCTS AND SUBSISTENCE GARDENING.

Populations in the Appalachia region rely upon the natural environment for a range of activities including the harvesting of non-traditional forest products and subsistence gardening. Both activities are more difficult to document than traditional economic activity, however, a growing amount of research shows a significant reliance upon these activities. There is a cultural tradition in the region of reliance upon the harvesting of non-traditional forest products and subsistence gardens rather than welfare or other public assistance. This reliance upon the natural environment becomes part of a work ethic of sorts which centers around frequently isolated and tightly knit communities. “Phoebe Fields, raised her [family of 17] practically herself, growing most of their own food,… none of [the] siblings has ever received government assistance” (Wenger 1998). A recent study from the West Virginia University found that environmental concern was highest in the most rural, low educated, nonprofessional population in the state (Ward 1999). This type of result reflects not only reaction to the mining industries, but also concern for their livelihood.

Estimated to account for 970 million dollars of a global market worth over 60 billion dollars (Hammett and Chamberlain 1998) the market for non-traditional forest products is estimated to have grown “by nearly 20 percent annually over the last several years”. Non-traditional forest products include sassafras, ginseng, goldenseal, mayapple, slippery elm and other botanical products which can be harvested in the Southern Appalachia region. The market specifically for “wild” ginseng can be worth between 350 to 500 dollars per pound dried, as compared to so called “tame” ginseng harvested in other regions of the country worth roughly 25 to 50 dollars per pound (Hufford 1998). In the Appalachia region specifically, the harvesting of non-traditional forest products contributes a significant amount to the local economy. In 1995, non-traditional forest products contributed an estimated 35 million dollars to Virginia’s economy (Hammett and Chamberlain 1998).

The natural environment, specifically small patches of rich soils, further contributes to the livelihood of people within this region. This region is not known for its prime farmland, however, small patches of good soil too small to be documented in traditional surveys, occur in the mountains of Appalachia. According to Mary Hufford, of the Library of Congress, official sources with the Soil Conservation Service report “as much organic matter as any prime farmland in the midwest occurs in Appalachia. Land is used for community and private subsistence gardening.

Much of the knowledge about non-traditional forest products, including folk medicine, or "home remedies," is passed down from generation to generation as a part of family traditions. The populations in this region also have an unusual relationship to the land itself. Much of the land from which non-traditional forest products are harvested is owned by private landowners. (Hammett and Chamberlain, 1998) A history of public admittance to this land is referred to as "the commons" or "the mountains," by which the population traditionally had understood access to the land.

Frequently, colloquial place names given to the landscape of these commons reflects an oral history of land use and community settlement. In a letter to the West Virginia Governor's Taskforce, Mary

Hufford writes, "Through continuous use of this commons . . . residents have kept alive a history reaching back to pre-Civil War settlement. Place names and stories attached to ridges, knobs, hollows, homeplaces, cemeteries, rock shelters, newgrounds, roads and trails scattered all over ‘the mountains' keep this heritage alive" (Hufford, 1998).

This identity with common geography creates a culture that is closely tied to mountains, which are by tradition a common asset. In a public comment letter, West Virginia resident Al Justice writes, "Unlike the plains of the Midwest, mountain farmers and miners were accustomed to living within their environment. Integrated so closely to the cycles of nature in the mountains, they were in fact part of the mountains in both humanistic and environmental terms" (Justice, 1999).

The harvesting of forest products is also linked to social activity in the region. In the springtime throughout Southern Appalachia a number of feasts and community gatherings center around the collection of ramps, (wild leeks, *Allium tricoccum*) which are the first of the wild foods able to be harvested. "Historically, in these mountains, female sociality has flourished around the gathering and processing of greens and other wild produce." (Hufford, 1998) These spring festivals allow Appalachian residents to display and reinforce their cultural heritage by sharing music, stories, and handicrafts, such as basket weaving and quilting (Appalachian Tales, 2000).

In recent years, the evolution of mining practices from underground to surface mining has affected the public's relationship to "the commons." Historically, underground mining operations allowed for surface land uses such as gardening or wild gathering to take place. Surface mining operations, by nature, do not allow for concurrent alternate land uses. Therefore, private landowners have increasingly begun to close off these lands to the public. This has a deep cultural as well as economic impact upon the communities in the region.

U. SOCIAL AND CULTURAL CONNECTIONS TO COAL MINING AND THE NATURAL ENVIRONMENT

Coal mining practices have profoundly affected the communities and residents of the Appalachian coalfields since coal mining first commenced in the region. Sections III.U.1. through III.U.4. provide an overview of the past and current interaction between the coal mining industry and the residents of Appalachia.

Appalachian coalfield residents have a unique social and cultural connection to the natural environment. For coalfield residents, the quality of the natural environment is important both as a source of income and an integral element of Appalachian culture. Sections III.U.5. and III. U.6. present an overview of the relationship between the natural environment, Appalachian culture, and coal mining.

IDENTITY WITH COMMON GEOGRAPHY CREATES A CULTURE WHICH IS CLOSELY TIED TO MOUNTAINS, WHICH ARE BY TRADITION A COMMON ASSET. IN RECENT YEARS, PRIVATE LAND OWNERS HAVE INCREASINGLY BEGUN TO CLOSE OFF THESE LANDS TO THE PUBLIC, HAVING A DEEP CULTURAL AS WELL AS ECONOMIC IMPACT UPON THE COMMUNITIES IN THE REGION.

1. Company Town Social Environment

Today, the company town structure has largely disappeared across Appalachia. Throughout the 20th century, however, company towns played an important role in the life of Appalachian residents. "Social Control, Social Displacement and Coal Mining in the Cumberland Plateau, 1880-1930", written by Dr. James B. Jones, provides a general overview of company town structure. Selected passages are presented within this section.

While company towns existed in many parts of the United States in the first half of the 20th century, the effects of coal company towns in the Appalachian Mountains were more far reaching. The mining company controlled nearly every essential aspect of community life, from work, to shopping, education, retail merchandising, and medical care.

The social structure of these company towns was impacted by the paternalistic nature of the relationship between the company and the residents, resulting in a highly dependent relationship for the residents. Research indicates that this typical company town relationship has both psychological and physical manifestations. The nature of company towns has been documented across numerous industries; however, the relative isolation of the communities, the predominance of the coal industry and the relative poverty of the region prior to industrialization all arguably contribute to a more pronounced community structure based on company paternalism.

Despite the varying quality of the provided infrastructure, it was frequently much needed in the isolated communities of Appalachia. With the withdrawal of the coal company from a local community, infrastructure is abandoned. In some cases the impact is visual, such as dilapidated, abandoned housing; however, in other cases, it has a direct effect on the quality of life of the residents such as lack of potable water or the closing of local schools. In addition to the lack of physical infrastructure, the paternal role of coal companies extended to the maintenance of these systems. Local communities frequently do not have a civic structure in place to take-over the maintenance of public infrastructure systems. One community member from McDowell County, West Virginia described the abandoned water system in her community as follows: "There'd be worms coming out of your spicket… The only thing we use our water for is to clean… We don't cook with it. We don't drink it. We haul all our water from a mountain spring." (Beyond Measure 1995)

Researchers looking at typical coal mining communities, specifically company towns, have noted a number of social themes in the development and mentality of residents including a sense of resignation, and feelings of lack of mastery in individuals lives. It is a logical progression that residents living in communities commanded by one powerful group should feel a lack of control over their own lives. This feeling of lack of control and mastery in both an individual and collective sense leaves the community as a whole ill-prepared to cope with the decline in the coal industry and specifically the shut-down of the local mines.

Herman R. Lantz studied a typical coal mining community in Pennsylvania at the middle of the century. An important reason this particular town was chosen was the experience of rapid development and significant economic decline related to the coal industry. Lantz's research clearly indicated that the residents lacked the motivation and even an aversion to taking advantage of new opportunities and enterprise; they had a feeling of "resignation" (Lantz 64). Lantz concluded that this resignation was only partially due to the social framework of the company-resident relationship. He attributes this phenomenon in part to the nature and culture of the people who settled the area. Pre-industrial settlers came from impoverished and marginalized populations in Western Europe. These populations were predisposed to feelings of aversion to social change (Lantz 1964). The experience of the mine workers, the boom and bust cycle, fed into an overall fear of industrial change and feelings of inadequacy in terms of coping with that continuous change. "…The many years of tenuous living associated with mining foster in the miner futility about his having any control over his life or his destiny." (Lantz 1958).

The phenomenon of lack of motivation and feelings of hopelessness has been documented on a more individual level as well. Research done in a small community impacted by a plant closing, (the Radio Corporation of America plant) indicated that the majority of the displaced workers agreed with the statement: 'No matter what I do it will be near impossible to find a job in the months ahead.' (Perrucci, et al. 1985). Lantz research suggests that in fact, when faced with new opportunities "It is difficult for the people to maintain consistent interest in almost any enterprise, since they have serious doubts about things turning out well for them." (1964).

A decline in the physical state of the community creates a downward spiraling effect on the economic plight of the local residents as well. As described previously, coal companies frequently built and maintained local infrastructure, from housing to plumbing and even churches, in the coal towns of Appalachia in varying degrees of quality.

2. Evolution of Unions in the Coal Mining Industry

Conditions leading to and necessitating the bituminous fields' unionization were many and sufficient to inspire the formation of a national union. While the coal field unions of Pennsylvania and the Midwest were organized effectively within a few decades of the United Mine Workers of America. (UMWA) formation in 1890, those of central Appalachia, specifically eastern Kentucky and West Virginia, were far more difficult to incorporate into the union holdings (Lockard 1998). Miners in these areas lived largely in company towns tucked into isolated hollows between hills, bound by contracts which guaranteed the loss of their jobs and homes should they participate in union activity; unionization was branded "socialist" and "communist" by mine owners, who claimed that union demands would break company banks and make mining unprofitable–and therefore impossible (Scott 1995, Kahn,1973).

It was during the first third of the twentieth century in general that struggles between the miners and the coal companies in central Appalachia escalated to the status of "Mine Wars". The sub-cultural identity and unity based on class consciousness which company town living fostered led miners to rise up in conflicts with coal company operators, staff, and agents; the Paint-Cabin Creek War of 1912-1913, the Mingo-Logan Mine War of 1919-1921, and the Northern Coal Field War of 1925-31, all in West Virginia, followed by the Harlan County, Kentucky, strike and violence of 1931-1939, were all examples of protests for local miners' demands which turned into miner-company clashes violent and ugly enough to draw national attention (R. Lewis 2000). "War" was an accurate name for the situation; Appalachian communities suffered greatly at the union-operator impasse.

The election of Franklin D. Roosevelt in 1932 ushered in a new era for labor unions in the U.S. The UMWA rode the wave of rank-and-file union drive to a new high of union membership, and by September of 1933, more than 90% of the bituminous coal mines in the U.S. worked under UMWA agreements (Singer, 1996).

3. Mechanization of the Coal Mining Industry

As the unionization was changing work conditions in the mines, the characterization of mining methods was also profoundly changing work conditions in the mines and social conditions in the coalfields. Today , coal mining is characterized by relatively high-paying but less abundant jobs. For example, from January 1987 to December 1996, roughly one out of every two mining employees lost their jobs in southwestern Virginia. In Dickenson County, mining employment decreased by more than half in a two year period from 1,401 workers in 1993 to 694 at the end of 1995 (Mooney 1998). Many of the jobs that remain are specialized, skilled labor positions. A Virginia Center for Coal and Energy Research study concluded that the future coal industry will be "a highly technical, highly mechanized industry run by just a few very skilled individuals who are going to be very well compensated" (Mooney 1998).

Inside the mines, there are fewer workers and job descriptions have become increasingly specialized. Since miners are no longer trained to do most jobs in the mine, their ability to share work or assist a co-worker is eliminated. The shift to skilled and specialized labor meant a shift to a commuter workforce and away from the company town system.

4. Local Culture and Ties to the Natural Environment

There is a great deal of literature and study on the distinct way of life known as the Appalachian culture. The nature of the Appalachian culture has shaped the manner in which company town residents react to the loss of jobs and community. While some scholars debate the beginnings of this unique culture, most agree on the common traits of which it is composed. Appalachians are thought to be pioneering in nature, strong, independent and resilient. Appalachian women in particular are considered hardier and more resourceful out of necessity; one local to Whitesville, WV referred to them as "Iron Weed" women (Judy Bonds, December 2000). Anecdotal evidence suggests that the female employment in Appalachia has been more widely accepted historically than in the rest of the country, again a phenomenon born of necessity. Based on these traits, the company town residents are well prepared to face situations of economic hardship.

In some cases however, the independent nature of the culture has made the transition from coal mining jobs to a more diversified and frequently less skilled job market difficult. Traditionally, men working in the mines held on to their independent nature within the workplace largely until mechanization. Anecdotal evidence also suggests, that many Appalachian men have more difficulty than women accepting lower-skilled and frequently lower-paying jobs in replacement of the coal mining jobs (Judy Bonds, December 2000). The loss of employment is a statement about a man's traditional role as breadwinner, whereas, a woman would be more significantly impacted by her inability to care for her family and children (Perrucci, etc. 1985) (Broman, etc. 1990). Social research into the impacts of unemployment also show that men are often more susceptible to depression related to job loss than women.

The cultural ties to the Appalachian region are also strongly seen in discussion of population migration as a result of mine closures. As families disperse, frequently it is understood that given time they will return to Appalachia. Migration is thought to be temporary. (Montgomery, 1968). While this is frequently not the case, it demonstrates the psychological ties that remain. The wife of a miner, trapped by poverty and her husband's black lung illness in Cincinnati said, "Maybe there's some way we can find to make it, to survive. If we find a way, I imagine we'll go back home to Kentucky and just stay there until we die." (Chandler, 1973). Part of the belief that migration is temporary stems from the typical boom and bust cycle of mining work. When a local mine is shut-down, there is a period within the community when residents still believe it will re-open despite repeated and clear signs from the companies. Initial migration is thought to be temporary until the mine re-opens; however, ultimately this is not the case. "People had been through the boom and bust cycle so many times that they just said… go on down to North Carolina and get you a job for a little while. And then, when they open up the mines back up you can come home and work… For about a year, people kinda kept that hope alive." (Beyond Measure, 1995)

V. RELATIONSHIP OF SURFACE MINING AND AIR QUALITY

1. Discussion of Study Area Air Quality

Surface mining involves a number of activities that can impact air quality or generate noise. Blasting activities are a particular concern in that they can produce particulate matter, fumes, and potentially damaging low-frequency noise and pressure waves. Basic equipment operation in the disturbed areas of mine pits, backfill areas, and haul roads can generate airborne particulate matter. Wind passage over open areas of mine sites also produces airborne particulate matter. Truck haulage of coal on public roads is also a source of particulate matter. Applicable statutory provisions are summarized in the human and community programmatic review presented in Appendix B. Performance standards for the protection of air quality are also discussed in Appendix B.

There are 42 monitoring stations located in the study area. Except for ozone levels, monitoring stations in the study area reported good air quality for all criteria air pollutants. Stations monitoring ozone concentrations in Boyd and Greenup Counties (KY) reported multiple years where levels exceeded EPA air quality standards.

2. Effects of Blasting on Air Quality

Potential health risks of airborne dust and fumes from blasting and other mining operations generally result from inhalation of particulate matter, fugitive dust, and re-entrained dust emanating from the mining operations. Fugitive dust usually refers to the particulate matter that becomes airborne due to the forces of wind and is not emitted from a stationary source such as a stack. Re-entrained dust is that which is put into the air by vehicles driving over dusty roads.

A study was recently completed by the Department of Mining Engineering at West Virginia University which included the study of dust and fume emissions from 10 blasting events at three mines. The results of this initial study indicate that detectable concentrations of respirable dust, total dust, nitrogen dioxide, nitric oxide, carbon monoxide and ammonia were found in ambient air at locations both in close proximity to the mining operation and at a distance greater than 1,000 feet from the blasting operations. Although specified in the Work Plan, crystalline silica measurements were not performed as a part of this study. Crystalline silica monitoring is needed to evaluate potential health risks associated with silicosis.

A significant reduction in detected concentrations of measured contaminants was found when the distance from the blasting operations was increased. This investigation was concerned with fugitive dust and fumes and investigators found no indication that there are any significant health risks due to exposure when no personnel are in close proximity to the blast zone. Conclusions of this investigation indicate that fugitive dust and fume emissions present no potential health problem for the following reasons:

- No event produced any "harmful" levels of any duration at distances exceeding 1,000 feet, except one measurement of 3.6 ppm NO_2 at 1,251 feet;
- The NO_2 measurement at 1,251 feet and all others were of short duration;

- Fugitive emissions are those that leave the property; if the property boundary is closer than 2,000 feet, persons within this area are evacuated.

The study included a discussion concerning four-wheel drive vehicles which can produce 75 pounds of fugitive dust per mile traveled on a dirt road (Hesketh, 1983), and that many county roads in the vicinity of a surface mine are unpaved; therefore, blasting would appear to be an unlikely source of significant dust at off-site locations.

The text of the West Virginia University Mine Dust and Blasting Fumes Study can be found in Appendix G of the EIS.

3. Effects of Hauling on Air Quality

a. On-site Heavy Equipment

Heavy equipment used during mining operations release the following criteria pollutants: nitrogen oxide (NO_x), sulfur oxide (SO_x), volatile organic compounds (VOCs), and carbon monoxide (CO).

b. Dust and Other Pollutants along Transport Roads

Hauling extracted coal from surface mines requires the use of trucks, trains or conveyors**.** The equipment used to haul the coal and other waste materials from the surface mines generates particulate from disturbance of the ground surface. Additionally, this transportation equipment also may emit NO_x, CO, SO_x and VOCs.

4. Effects of Mining on Air Quality

a. Particulates Released During Mining

Surface mining operations involve the release of particulates into ambient air during operations. Particulates can affect human health, animal health and can negatively impact crop growth. The EPA enforces National Ambient Air Quality Standards (NAAQS). There is a NAAQ standard for particulate matter sized at 10 microns in diameter or smaller, referred to as PM-10 emissions. Regulatory standards and guidelines for airborne dusts and fumes are further discussed in subsection 7 of this section.

b. Crystalline Silica

One issue of particular concern in the mining industry is exposure to crystalline silica. Workers in both surface and subsurface mining operations have the potential to be exposed to crystalline silica. Surface mine workers operating highwall drills, end loaders, dozers and trucks on mine property have a high probability of exposure to silica-containing dust.

Respirable dust disease, a progressive pulmonary disorder that builds up over years of inhaling high levels of airborne dust particles, is known in many forms: coal miners' pneumoconiosis, black lung disease, silicosis, and asbestosis. Government studies estimate that between 1,600 and 3,600 working miners and retirees has one of these fatal lung disorders. Ron Eller, director of the University of Kentucky's Appalachian Center, stated in the Louisville Courier-Journal, "Almost every family in Central Appalachia has a family member who died of black-lung disease. It's as ordinary as diabetes or high blood pressure or cancer in the region" (Harris, 1998).

5. State Implementation Plans

The 1990 Clean Air Act is a federal law which covers the entire country. EPA establishes limits on primary National Ambient Air Quality Standards (NAAQS). Also under this law, States are required to develop State Implementation Plans (SIP). The SIP should explain how each state will perform activities to comply with the Clean Air Act. The SIP generally consists of a collection of regulations which the state will use to enforce the Clean Air Act. Each individual SIP is submitted to the EPA for approval. SIPs vary between states.

Air emissions associated with mining operations (such as blasting, earth and rock removal, transport-related dust) are considered "fugitive emissions" under the Clean Air Act. Thus far, mountaintop mining has not been considered to meet the criteria for major source air quality permits (Title V of the CAA), defined as sources which emit at least 250 tons/year of a regulated pollutant.

6. Regulatory Standards and Guidelines

The Environmental Protection Agency has established air quality standards to protect human health from dust and other forms of particulate air pollution. There are two National Ambient Air Quality standards (NAAQS) for dust. One standard applies to particulate matter sized at 10 microns in diameter or smaller (PM-10). In 1997, EPA also promulgated a NAAQS for particulate matter sized at 2.5 microns or smaller (PM-2.5), but there are no regulatory requirements associated with this standard as yet, and it is under litigation.

The PM-10 NAAQS pertains to all dusts that fit the aerodynamic diameter requirements. This includes the fugitive emissions which may contain crystalline silica. The NAAQS does not include specific limits on silica itself.

Air emissions associated with mining operations (such as blasting, earth and rock removal, transport-related dust) are considered "fugitive emissions" under the U.S. Clean Air Act (CAA) and the federal government generally does not have the authority to regulate fugitive emissions which are not associated with a permanent stationary source. Thus far, mountaintop mining has not been considered to meet the criteria for major source air quality permit (Title V of the CAA), defined as sources which emit at least 250 tons/year of a regulated pollutant. The West Virginia air pollution control program does not currently require best management practices nor does it issue air permits to mountaintop mining operations although the Surface Mining Control and Reclamation Act of 1977 (SMCRA) indicates mining permits may contain control practices for some fugitive emissions.

NIOSH has developed criteria documents pertaining to occupational exposure to respirable coal mine dust. The Recommended Exposure Limit (REL) established by NIOSH for exposure to respirable coal mine dust is 1 milligram per cubic meter of air. The NIOSH REL for occupational exposure to crystalline silica is 0.05 milligrams per cubic meter of air. The REL represents the upper limit of exposure for a worker for up to a 10-hour workday during a 40-hour work week. The NIOSH publication: Criteria for a Recommended Standard for Occupational Exposure to Respirable Coal Mine Dust, dated September 1995, contains historical sampling data for both surface and underground mines. These tables provide useful information concerning occupational exposures and may provide some insight into potential residential exposures for the sampled mines.

The Mine Safety and Health Administration maintains separate air monitoring requirements for mining operations and the requirements are designed to protect mine workers. The Permissible Exposure Limit for respirable coal mine dust adopted by MSHA is 2 milligrams per cubic meter of air. This standard is reduced when the content of respirable quartz (crystalline silica) in the coal dust is greater than 5 percent. Inspectors for MSHA have the authority to inspect each surface mine at least twice a year. MSHA inspectors collect both personal and area air samples for each mechanized mining unit. Area air samples at the intake of the mine are collected periodically. The location and type of samples collected by the MSHA inspector are based on several things, including the adequacy of the mine operator's dust control measures.

Coal mine operators are required to collect five respirable occupational exposure samples in each mechanized mining unit for each bimonthly sampling period. Additionally, the operators are required to collect work area air samples. MSHA requires that coal mine operators submit a "Ventilation System and Methane and Dust Control Plan" every six months. This plan must include information about ventilation equipment and operating parameters for dust control. Once again, most of the requirements pertain to the protection of the coal mine workers rather than the residential population living in the vicinity of the mine.

The World Health Organization (WHO-1986) recommended a "tentative health-based exposure limit" for respirable coal mine dust with less than 7 percent respirable quartz. This information is cited in the NIOSH Criteria for a Recommended standard document referenced above. According to the NIOSH reference, the risk of disease when using the WHO approach could be determined separately for each mine or group of mines.

Most established exposure limits for all of the potential contaminants associated with surface mining apply only to exposure in an occupational setting. The following is a list of references with exposure limits established for the "general population:"

- The Department of Energy has established Temporary Emergency Exposure Limits (TEELS) for over 1250 chemicals
- The California Environmental Protection Agency has established Recommended Exposure Limits for use in comparison of monitoring or modeled air contaminant concentrations
- EPA has established Acute Emergency Guidance Levels (AEGLS)
- The National Academy of Sciences has Short-term Public Emergency Guidance Levels (SPEGLs).

7. Potential Health Risks

Potential health risks of airborne dust and fumes from blasting and other mining operations generally result from inhalation of particulate matter, fugitive dust and reentrained dust emanating from the mining operations and hauling. Impacts to air quality are localized within the immediate area of the mining site. Increased awareness of the dust emitted from hauling operations in recent years has improved air quality problems associated with hauling in the vicinity of the mining operations.

In order for a negative health effect to occur, a complete exposure pathway must be in place. A complete exposure pathway exists if there is, (1) a source or chemical release from the source (i.e., fugitive dust and fumes and chemicals in these sources), (2) an exposure point where contact with the chemical can occur (residents coming into contact with the fugitive dust or fumes), and (3) an exposure route by which contact can occur (inhalation of the dust or fumes). If one of these components is missing, then the exposure pathway is considered incomplete and the potential for negative health effects is considered to be negligible (EPA, 1989).

Federal legislation has addressed the health and safety hazards associated with both surface and underground mining operations. Additionally, many state governments maintain regulatory bodies for the oversight of mining operations. Increased technology has also allowed for the use of remotely operated machinery to decrease workers' exposure to dangerous work environments, and the use of more sophisticated air monitoring equipment. Some states have implemented "free chest x-ray" programs for mine workers to provide diagnosis and treatment of work-related lung diseases.

One issue of particular concern in the mining industry is exposure to crystalline silica. Workers in both surface and subsurface mining operations have the potential to be exposed to crystalline silica. Surface mine workers operating highwall drills, end loaders, dozers and trucks on mine property have a high probability of exposure to silica-containing dust.

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Specific potential health effects associated with exposure to the fugitive dust and fumes emitted from mines are dependent on the chemical constituents of the emissions.

a Fugitive Dusts/Particulate Matter

Fugitive dust usually refers to the dust put into the atmosphere by the wind blowing over bare soil, plowed fields, dirt roads or desert or sandy areas with little or no vegetation. Reentrained dust is that which is put into the air by reason of vehicles driving over dirt roads (or dirty roads) and dusty areas. The emission rates of fugitive dusts are highly variable and dependent on the prevailing atmospheric conditions, including wind speed and direction.

Particulate matter (PM) of concern for protection of lung health are the fine particles. PM in the form of respirable coal mine dust are particles with aerodynamic diameters less than 10 microns. This size of airborne dust is capable of entering the lungs if inhaled. According to the American Lung Association, particles of special concern are less than 2.5 microns in diameter. These particles are more easily inhaled than larger sized particles and can either become embedded deeply into the lungs or absorbed into the bloodstream.

Inhalation of particulate matter air pollution is particularly harmful to sensitive members of the population who have pre-existing conditions such as asthma and chronic obstructive pulmonary disease. Inhalation of particulate matter containing respirable coal mine dust may lead to a condition called coal workers' pneumoconiosis. This condition is prevalent in coal mine workers who have worked in underground coal mines for a period of eight years or longer. Chronic bronchitis, emphysema and decreased lung function are also prevalent among coal mine workers. Pneumoconiosis is a general term used to describe lung diseases which have resulted from the inhalation of dust, usually inorganic (rock or mineral) dust.

Another form of pneumoconiosis associated with coal mining is silicosis. The inorganic dust exposure which causes silicosis is respirable crystalline silica. Silicosis is a nonreversible lung disease caused by inhalation and retention within the lungs of silica dioxide crystals. Silica is the second most common mineral in the earth's crust and a major component of sand, rock and mineral ores. In addition to silicosis, other lung diseases have been associated with inhalation of crystalline silica. These diseases include chronic bronchitis and tuberculosis.

There are three types of silicosis:

- Chronic silicosis occurs after 10 or more years of overexposure
- Accelerated silicosis results from higher exposures and develops over 5-10 years
- Acute silicosis occurs where exposures are the highest and can cause symptoms to develop within a few weeks to 5 years of exposure.

b Fumes Released During Blasting

Additional possible potential health effects associated with surface mining operations include those related to the potential inhalation of toxic fumes generated from the blasting operations. Blasting operations may involve the release of fumes including: carbon monoxide, nitrogen dioxide, nitric oxide and ammonia. The type and amount of fumes released is dependent on the frequency and type of blasting operation conducted for the particular mining operation.

Exposure to carbon monoxide causes a variety of health-related symptoms including headache, nausea, weakness and dizziness. Additionally, exposure to high concentrations of carbon monoxide results in a condition referred to as asphyxial anoxia in which there is inadequate oxygen delivery in the presence of adequate blood flow. Carbon monoxide is commonly referred to as a "chemical asphyxiant."

According to research published by the National Institute for Occupational Safety and Health (NIOSH), over the past 30 years, blasters have switched to using less expensive blasting agents such as ammonium nitrate/fuel oil (ANFO) mixtures. Ammonia is released during this combustion process. Exposure to ammonia causes eye and respiratory irritation.

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W. BLASTING AND THE LOCAL COMMUNITY

Because of the relatively close proximity of some mountaintop mining operations and populated areas within the EIS study area, blasting associated with mountaintop mining can impact local communities. Blasting activities are a particular concern in that they can produce particulate matter (dust), fumes, flyrock, ground vibrations, and air pressure waves (airblast). This section of the document focuses only on flyrock, ground vibrations, and air pressure waves produced by blasting at mountaintop mines. Air quality and potential health risk is discussed in Section V of this chapter.

1. Trends Associated With Blasting at Mountaintop Mining Sites

Blasting activities have used larger quantities of explosive materials to fracture greater amounts of coal mining overburden over the years as mining operations have increased in size and productivity. For example, the West Virginia Governor's task force reported that over the last 20 years, blast detonations associated with the larger mines have increased from approximately 100,000 pounds to over one million pounds of explosives. In addition to more explosives used in blasting, the time periods over which blasting may occur in a general location have changed. For example, as the location of a typical contour mine nears a house and passes, blasting influence may last for weeks or perhaps a few months. For a large mountaintop mine, removing multiple coal seams, the blasting near a home may last years. This occurs where numerous blasts facilitate overburden removal as underlying seams in the same location are successively mined. These trends have, in turn, exacerbated local citizens' perceived impacts of MTM/VF mining operations. Many of the comments received during scoping for this EIS dealt with concerns over impacts that were reportedly occurring to structures, water wells, and the general quality of life in communities as a result of blasting.

2. Studies Relating to the Impact of Blasting on the Community

A number of studies have been conducted over the years to determine the effects that blasting can have on traditional structures and wells. These studies were used in the development of OSM regulations, establishing thresholds for air blast and ground vibrations that would prevent injuries to persons or damage to public or private properties outside the permit area. Since the scale of blasting, as indicated above, has changed, and coalfield residents continue to allege blasting-related problems, OSM routinely evaluates the blasting control portion of the regulatory program to assure it adequately provides for protection of the public and property. For example, OSM recently performed a national review of 1,317 blasting complaints recorded over a one-year period (between July 1998 and June 1999). From readily available data in Federal and State files, collected as part of the national citizens' complaint review, the report entitled "Blasting Related Citizen Complaints in Kentucky, West Virginia, Virginia and Tennessee" was prepared (see Appendix G). The study gathered data in three general categories: (1) reason(s) for the complaint; (2) methods of investigation used in the complaint investigation; and (3) resolution of the complaint.

The following general observations are made from the study data.

- The EIS study area accounted for 54% of the blasting-related complaints nationally. If one mine in Pennsylvania (outside the EIS study area) were omitted, the EIS study area accounted for 72% of the complaints.
- Within the EIS study area, approximately 50% of the blasting-related complaints were lodged in West Virginia. Kentucky accounted for approximately 37%, with Virginia and Tennessee accounting for approximately 12% and 1%, respectively.
- Annoyance/noise concerns were a component of 75% of the blasting-related complaints in the EIS study area.
- Damage to structures (residential dwellings) was alleged in approximately 33% of the blasting-related complaints in the study area. In investigating these complaints, no instances of blast-induced vibration damage were found attributable to the mining operation by the regulatory authority.
- Alleged damage to domestic water systems was a component of approximately 14 percent of the blasting-related complaints in the study area. One of the investigations resulted in a finding of impact on water quantity or quality.
- Flyrock (earthen materials such as rock) beyond the permit boundary was alleged in approximately 2 percent of the blasting-related citizen complaints.

Investigations of blasting-related citizen complaints resulted in the issuance of a notice of violation and/or cessation order in the states within the EIS study area, as follows:

- 44 violations were issued in West Virginia in response to 30 of 352 complaints (9%).
- 36 violations were issued in Kentucky in response to 23 of 263 complaints (9%).
- 17 violations were issued in Virginia in response to 12 of 87 complaints (14%).
- No violations were issued in Tennessee in response to 6 complaints (0%).

Most of the violations were issued for exceeding vibration limits or keeping inadequate records and were generally issued for violations unrelated to the original complaint(s).

Occasionally, structures that either: 1) do not fall into the "typical" category; or, 2) may not have been included in the body of research data on which the SMCRA regulations were founded, are identified near proposed mine sites. An OSM study, entitled "Comparative Study of Structure Response to Coal Mine Blasting – Non-Traditional Structures" was designed to provide information on the impact of blasting on such structures (see Appendix G). Non-traditional structures may include pre-fabricated houses, trailers, log homes, sub-code homes and adobe structures. This study, conducted near eleven mine sites in nine states, measured the response characteristics of these structures to determine if the current rules provide for their protection, or if modified vibration limits were prudent. As in earlier studies of similar structures, this study concluded that certain types of non-traditional structures (e.g., those constructed of earth, masonry, or two story "camp" homes), responded more strongly than traditional frame or masonry structures to blasting vibrations and air blast. When these structures are present near coal mine blasting, lower site-specific limits may be a prudent action for the regulatory authority to take. This provision is currently an option for the regulatory authority that is provided within the existing regulatory program. This study provides the basis for site-specific investigations on non-traditional structures and should result in improved levels of protection for these structures.

Previous scientific research has generally not supported a connection between blasting and permanent adverse impacts to domestic water supplies (wells). The recent OSM study entitled "Comparative Study of Domestic Water Well Integrity to Coal Mine Blasting" was designed to determine if the available information on wells and impacts from blasting remained valid--considering the larger blasts that are typical in today's mountaintop mining operations. This study was conducted in southern West Virginia, eastern Kentucky, and southwestern Virginia. The study concluded that, similar to earlier studies on wells and blasting, few changes could be directly attributed to a blast event (e.g. no major differences in the observed water quality and well yield data). The study report related to blasting and water wells is under development, but an executive summary is provided in Appendix G.

3. Regulatory Standards and Guidelines

Federal SMCRA regulations related to blasting have not changed substantially since 1983. Under the SMCRA regulatory program, limitations and controls are placed on blasting with the intent of protecting public safety and limiting flyrock, airblast, and ground vibrations to prevent offsite damage to structures. The SMCRA regulatory program provides specific blasting-related performance standards that must be complied with when conducting mining operations. Mine permit applications are required to contain a blasting plan detailing the measures to protect surrounding areas from damage and adverse effects. The general public is notified of proposed mining activities by an advertisement placed in local newspapers at the time of the permit application. This plan can be reviewed by the public during the public comment period and discussed at public meetings.

The Federal rules require that all persons directly responsible for use of explosives on a mine site be trained and tested through a program that includes a written examination and demonstration of field experience. At a minimum, the training and testing includes the technical aspects of the blasting operations and State and Federal laws governing the storage, transportation and use of explosives. A certified blaster may utilize non-certified personnel as assistants in a blasting operation only when they are under the direction of and given on-the-job training by the blaster. Certifications may be suspended or revoked if the blaster violates Federal or State laws.

Once the permit is issued, coal operators are required to place blasting schedule announcements in local newspapers prior to initiation of blasting, and to continue to do so annually as long as blasting continues. At least 10 days prior to initiation of blasting, residents and owners of other structures within one half mile of the proposed blast sites are also mailed a blasting schedule. The blasting schedule mailing is required annually as long as blasting continues. The schedule outlines the location of proposed blasting, the dates and time periods of blasting, and the warning signals. The SMCRA regulatory authority must approve this schedule and can limit the blasting, if necessary and reasonable, in order to protect the public health and safety or welfare.

Pre-blast surveys are offered by mining operators at no cost to (or may be requested by) residents and owners of structures located within one-half mile of the permit area. These surveys are designed to identify any sensitive structures where additional safeguards may be necessary and to document conditions of structures near the mine site prior to blasting. This provides important baseline information to facilitate the resolution of potential blasting damage complaints. A pre-blast survey typically includes written documentation, supplemented by pictures, of existing structure condition, such as wall cracks, foundation cracks, and broken windows. 30 CFR Section 816.62 also requires that consideration be given to utilities and water systems during a pre-blast survey, however assessment of these structures may be limited to surface conditions and other readily available information. Well quantity measurements, such as pump tests or other yield estimates, are not typically included in pre-blast surveys. Copies of the pre-blast surveys are provided to both the resident and the regulatory authority.

Prior to initiation of blasting, signs warning of blasting activities must be placed at identified locations of possible public access to the site and must be maintained until blasting will no longer occur. Warning and all clear signals audible up to one-half mile from the blast site must be used in association with each blast. Access to the site prior to a blast must be controlled to prevent persons or livestock from entering the blast area. Once blasting is initiated, it must be conducted in a manner to prevent personal injury, damage to public or private property beyond the permit boundary, and adverse impacts to nearby underground mines or surface and groundwater availability outside the permit area. Specific limits on airblast, ground vibration, and flyrock are identified in regulations that will generally provide the required protections. If unique circumstances are identified in the pre-blast survey, as a result of a citizen's complaint, or through a mine site inspection, the regulatory authority can establish lower ground vibration or airblast limits to ensure prevention of damage. Detailed records of each blast must be maintained and available for review for at least 3 years.

SMCRA statutes and regulations provide a mechanism for anyone who has reason to believe that a violation of blasting or other requirements may have occurred to file a complaint with the regulatory agency. Generally, complaints are made to the regulatory agency, which will then investigate the complaint and render a written finding to the complainant. If the investigation confirms a violation, of blasting or any other requirement, enforcement action is taken against the coal operator. If citizens disagree with the findings of a complaint investigation, they have appeal rights in all four states within the EIS study area. The initial appeal is generally conducted internally by the regulatory agency. If a satisfactory resolution is not achieved in this way, appeals may proceed to civil court for judicial resolution, or though other agencies (the appeal agency varies in the individual states).

4. Recent Program Improvements

Although studies and surveys have shown current regulatory controls provide adequate protections for nearby properties/structures, SMCRA regulatory authorities recognize that blasting complaints continue at a relatively high level and are particularly contentious in the steep-slope coalfields where larger mining operations are adjacent to populated areas. While compliance records indicate that a relatively small number of blasts actually exceed performance standards, additional guidance, analysis tools, and training will increase the capabilities of inspectors and blasting specialists to further minimize blasting effects and more successfully address citizens' sensitivity to blasting issues.

OSM has several initiatives directly related to this issue. OSM recently developed and provided the Blast Log Evaluation Program (BLEP) to the state SMCRA programs as part of its Technical Information Processing System. BLEP is designed to help the mine inspectors compile blast log data to: 1) identify record-keeping problems; 2) identify unusual site conditions; 3) "red-flag" quality control problems by the blast crew; and 4) facilitate review by blasting specialists. The OSM

Blasting Guidance Manual (1987) is being rewritten to reflect the current technology and 15 years of regulatory experience on blasting. This manual not only assists in the evaluation of blasting complaints, but provides the coal mining industry with an awareness of the particular areas where regulatory focus will occur and methods for minimizing problems through blast design, controls, and monitoring techniques. Also, in addition to the basic technical training course entitled "Blasting and Inspection", the OSM National Technical Training Program has developed a class entitled "Advanced Blasting: Investigation and Analysis of Adverse Effects." This additional training places emphasis on monitoring and evaluating ground vibration and airblast to heighten the inspectors' understanding of potential adverse effects and may improve protection of nearby structures and potentially reduce nuisance impacts. The training describes the response of buildings to vibrations and teaches recognition of weather conditions when blasting would create more nuisances (e.g. days with temperature inversion). Training also explains the existing flexibility in blasting regulatory requirements that allow states to limit blasting based on site-specific conditions (i.e. use of pre-blast surveys), as well as re-evaluation of blasting limits if damage allegations arise. Increased technology transfer on the latest techniques and methods for assessment of potential adverse effects from blasting enhance the regulatory authorities' ability to:

- Monitor ground vibrations and airblast,
- Evaluate blasting records,
- Recognize unique site conditions,
- Adjust blasting plans accordingly, and
- Communicate more effectively with citizens.

West Virginia has also demonstrated a leadership role in passing laws and regulations that highlight the importance of mining companies being good corporate neighbors and addressing citizens' blasting concerns. The West Virginia Legislature and WVDEP have recently developed and implemented state statutes and regulations that created the Office of Explosives and Blasting (OEB). The OEB establishes dedicated blasting specialists and new regulatory standards including:

- For single permits of greater than 200 acres (or contiguous permits of 300 acres or more), revising the pre-blast survey requirements to 0.5 mile from the permit boundary or a distance of 0.7 mile from any proposed blasting site, whichever is greater;
- Requiring that a well water sample and yield test be part of the pre-blast survey;
- Mandating that those who conduct pre-blast surveys must be trained and certified, including a minimum of 12 hours of refresher training every three years for certified blasters;
- Implementing an improved blast damage claims process, whereby the state retains the services of independent, qualified third parties to evaluate claims of damage; and
- Developing a binding arbitration process for use if the determination of the third party investigator is challenged.

5. Conclusions

The blasting studies completed as a part of this EIS reveal that existing regulations provide appropriate controls for preventing damage to structures, including wells. OSM's recent programmatic oversight review of blasting-related citizen complaints confirmed that when blasting complaints occur, the complaints are investigated and responded to as required. The complaint study appears to indicate that, while blasting activities are noticeable by adjacent residents and often perceived to cause damage and trigger a complaint, the cases of confirmed blast-related damage comprise a small portion of total complaints. Additional research by OSM has not indicated that existing damage thresholds are inadequate. Moreover, the regulations provide for states to adjust limits in circumstances where lower damage thresholds are warranted. As such, the existing programmatic controls (statutes, regulations, policies, and guidance) provide adequate levels of protection. No additional actions to control blasting are warranted at this time. OSM diagnostic tools, training, and updated guidance should enhance application of the existing standards as well as blast monitoring and investigation of future complaints.

The agencies recognize that, in spite of enforcement of the existing regulations and implementation of the recent program improvements, blasting concerns/complaints will continue. Concerns and subsequent complaints are likely to decrease as a result of the identified recent program improvements. However, when mountaintop mining operations are near populated areas, complaints, particularly those related to noise and vibration of homes (nuisance impacts), may still occur in relatively high numbers. Although regulations provide a limited ability to control nuisance impacts (for example blasting may typically occur only between sunrise and sunset), these nuisance-type concerns will continue to have periodic adverse effects on the quality of life of residents living in close proximity to the mine sites. The regulations were designed to minimize damage potential and only indirectly address nuisance; however, citizens retain the right to take civil action against a mining operation for nuisance-related concerns. There have been court cases in the coalfields where mining activities have been ordered to adjust operational procedures (i.e., above-and-beyond existing regulatory program controls) to reduce public nuisances.